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## Experts Uncover the neXt generation of LENTIS IOLs

Innovative solutions for presbyopia,  
laser refractive cataract surgery IOLs, AMD, and more.



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# LENTIS Mplus<sup>X</sup>: Get Off the Peaks, Get Into the Zone

This segmented multifocal IOL addresses patient demands for a wide range of functional vision.

BY BEN WANDERS

Premium lenses have continued to evolve ever since 3M introduced the first multifocal IOL in the late 1980s. More recently, the unique optical design of the LENTIS Mplus IOL (Oculentis GmbH) again helped to revolutionize the premium IOL market. This one-piece zonal refractive lens was the first commercially available IOL to have a rotationally asymmetric design. It features plate haptics and two refractive segments, a large aspheric distance-vision zone and a sector-shaped near vision zone with an addition of 3.00 D to direct light to a near focal point.

We have enjoyed much success with the LENTIS Mplus IOL over the past 5 years. With more than 200,000 IOLs implanted worldwide and many clinical studies that have shown excellent visual results and exceptional patient satisfaction, this lens represents a significant improvement over conventional diffractive multifocal systems. It provides patients with better contrast sensitivity and balanced vision compared with IOLs using a rotationally symmetric design.

With that said, there are a few areas in which improvements are possible with the Mplus IOL, including near (reading) vision, pupil independency, and depth of focus. The key motivator behind modifying the Mplus IOL was to enhance and extend the entire depth of focus, rather than improving any individual focal point.

The Mplus X technology features two major innovations compared with the Mplus (Figure 1): additive paraxial asphericity (APA) and surface design optimization (SDO).

APA describes a central modification that broadens the two foci into far and near focus zones. The objective of this is to achieve a general enhancement and extension of the depth of focus, not just an improvement of individual focus points. The defocus curve of the Mplus X visualizes the following: Instead of being limited to the maximization of peaks in near, intermediate, and far vision, the Mplus X maximizes the total area under the defocus curve, which corresponds to the entire viewing zone (Figure 2).

APA also simplifies neuronal image interpretation by the retinal cones and rods due to intelligent focal modulation. Depending on light condition and pupil size, the APA cre-



Figure 1. Compared with the LENTIS Mplus IOL (left), the Mplus X IOL (right) features additive paraxial asphericity and surface design optimization.

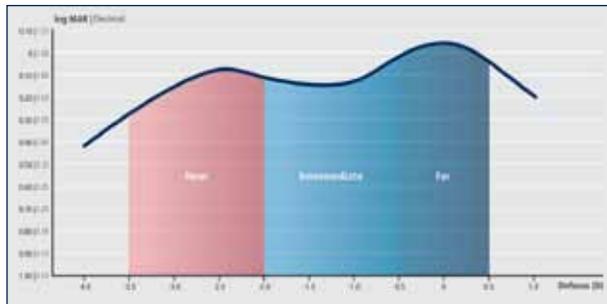


Figure 2. Defocus curve of the LENTIS Mplus X IOL in 40 eyes.

ates a retinal image that is tailored to the then-prevailing resolutional capability of the retinal pigment epithelium (Figure 3). The second innovation of the Mplus design is called SDO. By enlarging the near vision segment, the Mplus X is now more pupil independent and provides better reading performance. Second, by minimizing the transition between the two optic zones, light efficiency of more than 95% is achieved (Figure 4).

Additionally, the homogeneous optic-haptic transition significantly reduces the incidence of photic phenomena.

## CONCLUSION

The next-generation LENTIS Mplus X IOL is clearly the evolution that will take refractive cataract surgery to the next level. It will allow surgeons to provide their patients with an exceptionally wide range of functional vision

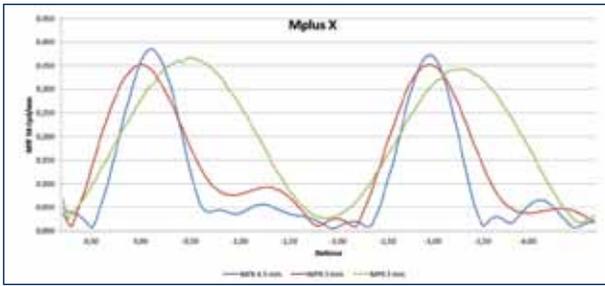


Figure 3. Modular transfer function curves for various pupil sizes.

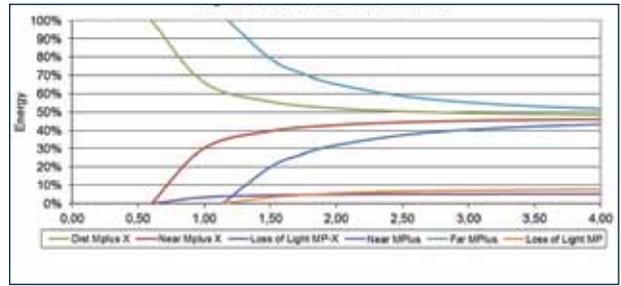


Figure 4. Light distribution with the Mplus and Mplus X IOLs.

across the far, near, and intermediate foci.

As with all multifocal systems, the benefits of a lens design come with known tradeoffs, but the central focus of the LENTIS Mplus X development has been to marginalize the tradeoffs to an absolute minimum. The result is better contrast sensitivity, more light transmission, and better night vision. All of these features have been improved compared with the current LENTIS Mplus design, and, therefore, are far superior to conventional diffractive systems.

In the following articles, surgeons from the international ophthalmic community provide their insights and initial clinical results on the new LENTIS Mplus X and share their extensive experience with the Mplus technology. ■

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# Visual Function With the LENTIS Mplus X IOL

Providing better vision in the intermediate and near ranges.

BY SUNIL SHAH, MBBS, FRCOPHTH, FRCS(Ed), FBCLA

Today, the majority of cataract surgeons rely on multifocal IOLs to provide our patients with a wider range of vision than a standard monofocal lens can achieve. For the past several years, one of the lenses that I commonly used was the LENTIS Mplus IOL (Oculentis GmbH). With its rotationally asymmetrical design, this lens dedicates most of its optic to distance vision and minimizes a loss of distance contrast sensitivity at night as well as photic phenomena—two of the most common negative side effects associated with multifocal IOLs. Now that the LENTIS Mplus X is available, it is quickly becoming my lens of choice (Figure 1).

## COMPARATIVE STUDY

We recently compared results of our first 20 cases with the new Mplus X IOL to our historical data on the first-generation Mplus IOL. The patients were all of a standard age for cataract surgery and underwent bilateral lens implantation. In the Mplus X group, the mean age was  $67.2 \pm 11.5$  years, and all patients were examined at 3 months postoperative. Although the assessments were extensive, below are some of

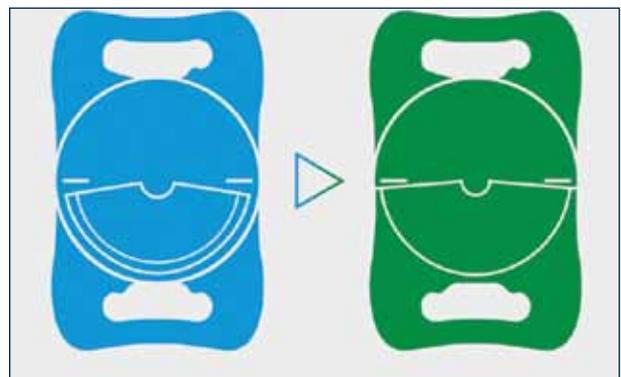
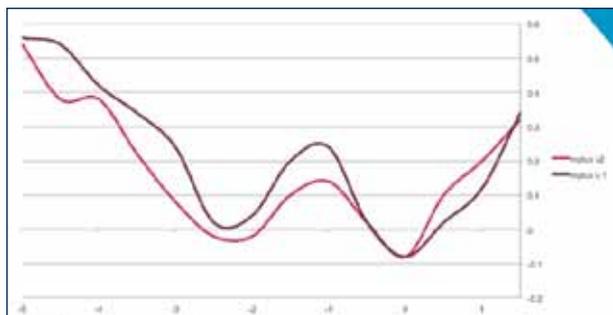


Figure 1. The LENTIS Mplus (left) and Mplus X (right) IOLs.

the basic results for patients who received the Mplus X IOL.

**Defocus curve.** The most telling way to determine a lens' effectiveness is by using defocus curves of BCVAs. This curve represents the average data for a patient population. But, in order for the defocus curve to accurately depict the effect of the lens and not just an individual patient, all refractive errors must be corrected before the defocus is measured.



**Figure 2. Defocus curve of one patient with the LENTIS Mplus IOL implanted in one eye and the Mplus X IOL in the other.**

In comparison to defocus curves for traditional multifocal IOLs, which have a significant dip or peak at the intermediate distance, the monocular and binocular defocus curves of the LENTIS Mplus X are both relatively flat, meaning that the lens provides a similar acuity for intermediate vision as it does for reading vision. Naturally, the binocular defocus curve is slightly better than the monocular defocus curve since it represents the entire viewing system. Nonetheless, both are equally impressive compared with the defocus curves we have seen with other multifocal IOLs.

Figure 2 shows the defocus curve of one patient who has the first-generation LENTIS Mplus IOL implanted in one eye and the LENTIS Mplus X in the other. Although the curves are similar, near visual acuity is better than 0.00 logMAR with the LENTIS Mplus X lens. This is a slight improvement from the near visual acuity with the standard Mplus IOL. Likewise, the intermediate visual acuity is better with the LENTIS Mplus X IOL, and this improvement is more significant. I am not

saying that the Mplus is a bad lens—I have achieved impressive results with it. However, in terms of visual improvements between the Mplus and Mplus X lenses, it is clear that the Mplus X achieves even better near and intermediate vision.

We have also performed halometry to determine the presence of glare around a point source of the lens. For the Mplus X, it was less than 0.7°. If this is compared with other lenses, it is a significant improvement.

## CONCLUSION

Just like the LENTIS Mplus, the LENTIS Mplus X IOL has excellent contrast sensitivity. Additionally, this new lens provides patients with significantly better intermediate vision and, on average, 1 more line of near visual acuity. It also performs similarly to the first-generation Mplus IOL under photopic and mesopic conditions.

In addition to the benefit of providing a wide range of functional vision, the Mplus X lens design addresses the minimal drawbacks of the first-generation design. Although it is not a trifocal lens, the results are probably better than what we can achieve with a trifocal. Therefore, the LENTIS Mplus X is a welcomed addition to my armamentarium of IOLs.

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## PERSONAL EXPERIENCE WITH THE LENTIS MPLUS X IOL

*By Hiroyuki Arai, MD, PhD; Detlev R.H. Breyer, MD; and Dominique Pietrini, MD*

### 1. What is your experience with the current LENTIS Mplus?

**Dr. Arai:** The performance of the LENTIS Mplus is good; however, some patients complained about weak near vision and the occurrence of ghost images. In Japan, I am a pioneer in incorporating lens designs into my practice, and, since 2002, I have consistently introduced the latest accommodating and multifocal IOLs. The first multifocal IOL I implanted was the Array (Advanced Medical Optics Inc; no longer available), and since then I have implanted 920 premium IOLs—506 AT LISA lenses (Carl Zeiss Meditec) and 315 LENTIS Mplus IOLs. I started implanting the fourth-generation multifocal IOLs of the Mplus and AT LISA, the LENTIS Mplus X and AT LISA tri 839MP, respectively, last year.

**Dr. Breyer:** Nearly none of my patients who receive the IOL and in whom the lens is centered perfectly complain about halos and glare or other photic phenomena. On the other hand, patients with rotationally symmetrical IOLs often have these complaints.

The unparalleled capability of light transmission with the LENTIS Mplus is a further advantage for patients who drive or work a lot at night or under dim light conditions. The key to achieving good, consistent results is the correct centration of the IOL in the visual axis. Excellent far and intermediate vision is a further argument for

the IOL. In patients who do not achieve spectacle independence for near vision tasks like reading, I implant a supplementary IOL after a contact lens trial to hit the target refraction perfectly. This is explained in advance in the preoperative informed consent.

**Dr. Pietrini:** I routinely use multifocal IOLs for patients undergoing cataract and clear lens extraction surgeries. During the past few years, I have used many IOLs of the LENTIS platform, including the Comfort, the Mplus, and the Mplus Toric, mainly for their high capacity of light transmission and low levels of photic phenomena. The loss of light is around 7%, versus 14% to 22% for IOLs with diffractive optics. Considering the rotationally asymmetric optical design of the Mplus, far and intermediate visual acuity are excellent, and this range of vision is crucial for younger patients, for those who drive extensively, and for avid computers users.

### 2. What is your current lens of choice for presbyopia correction?

**Dr. Arai:** Initial outcomes are marvelous, and the IOL provides clear vision from far to near distances. Due to its design, the loss of light is minimal and, therefore, patients do not complain about night driving problems or waxy vision.

**Dr. Breyer:** Not only do I try to meet my patients' visual needs, but I also try to minimize the number who are unsatisfied postoperatively. Most times, patients complain of photic phenomena. Whenever I suspect that a patient is susceptible to photic phenomena, I prefer

PERSONAL EXPERIENCE WITH THE LENTIS MPLUS X IOL (CONTINUED)

the rotationally asymmetrical design of the LENTIS Mplus X or a trifocal IOL. According to our studies, these two lens designs produce the least potential for explanation due to halos and glare.

If the patient is not a night driver, does not have the potential for problems with halos and glare, and wants to read without glasses, we recommend the LENTIS Mplus X. I also suggest blended vision, implanting a rotationally symmetrical multifocal IOL with a near add of at least 3.00 D in the nondominant eye and a near add of around 2.50 D in the dominant eye.

**Dr. Pietrini:** The LENTIS Mplus delivers excellent visual acuity at all distances, including intermediate visual acuity, which is often impaired with bifocal diffractive IOLs. Night vision is preserved, and this is one of the biggest advantages of the Mplus because night vision problems are a frequent complaint associated with multifocal IOLs.

3. How do you rate your first results with LENTIS Mplus X?

**Dr. Arai:** With the new LENTIS Mplus X, there have been no complaints about night driving or waxy vision. I assume it is because of the larger lens area for near vision (on the pupil area) and the smooth transition between the near and far vision segments. Furthermore, there is significant improvement in intermediate vision with the LENTIS Mplus X.

I expected that the AT LISA tri 839MP would also have good performance; however, several of my patients have complained about weakness of near vision, which I believe is caused by the different add power of the lens (from 3.75 to 3.33 D). Furthermore, there have been a few complaints about waxy vision. I think this is inevitable with any diffractive multifocal IOL model.

**Dr. Breyer:** Patients are more satisfied, with consistent reading capabilities and less loss of intermediate vision. Halos and glare seem to occur less often than they did with the previous Mplus design. I like to combine the LENTIS Mplus X with the LENTIS Comfort (Oculentis GmbH) with a near add of 1.50 D in the dominant eye. This combination seems to have high gains in vision but with a low risk profile.

**Dr. Pietrini:** We have recently implanted our first 10 patients with the LENTIS Mplus X, selecting patients with low-grade cataracts and good intended BCVA after surgery. The mean spherical equivalent at 1 month was -0.10 D, mean distance UCVA was 0.93, intermediate UCVA was 0.69, and near vision was J1. No patients complained about photic phenomena such as halos.

4. Has overall patient satisfaction improved with the new LENTIS Mplus X?

**Dr. Arai:** I acknowledge the advantage of the LENTIS Mplus X IOL and, therefore, at the moment it is my first choice among multifocal IOLs. I also expect wonderful outcomes and good patient satisfaction after implantation of the LENTIS Mplus Xtoric.

**Dr. Breyer:** Yes, especially for those patients with a strong desire to read without glasses.

**Dr. Pietrini:** The depth of field provided by the LENTIS Mplus X has been extended to provide better near and intermediate visual acuity. Additionally, patients can maintain a high level of night vision quality.

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# Early Results With the LENTIS Mplus Xtoric IOL

This lens provides good visual acuity for near, intermediate, and distance vision for both men and women.

BY MAGDA RAU, MD

Over the years, I have noticed and verified with my previous studies that patient satisfaction with multifocal IOLs partially depends on the gender of the patient. The reason for this is likely that men and women have different requirements of vision: Whereas women tend to attach greater importance to near vision and are more demanding of spectacle independence for reading, men tend to favor clear distance vision and are more both-

ered by photic phenomena like halos and glare.

As a result, for years I have been strategic about implanting a diffractive multifocal IOL or a refractive multifocal IOL with a near-dominant central zone in women and a refractive IOL with a distance-dominant central zone in men. I also tended to use a mix-and-match strategy with previous multifocal IOLs, to use their advantages and eliminate the disadvantages, especially for patients who desired perfect vision at distance as well near.

When I began using the LENTIS Mplus IOL (Oculentis GmbH) a few years ago, my results followed the same gender trend. Although the majority of patients (90%) were satisfied after surgery, 8% of women were not satisfied with their near vision, and 1% of men were disappointed with the incidence of halos and glare during night driving. Another 1% was not satisfied with their poor near vision.

### MPLUS AND MPLUS XTORIC IOLS

Once the Mplus Toric IOL became commercially available, I began implanting the lens in both my male and female patients. The Mplus Toric IOL can be customized to enable exact correction of presbyopia and corneal astigmatism and is available from 0.00 to 36.00 D of sphere and 0.25 to 12.00 D of cylinder, both in steps of 0.01 D. Generally speaking, patients are extremely satisfied with their vision after implantation of the Mplus Toric; however, for some patients the quality of near visual acuity is not satisfactory. The latest design, the Mplus Xtoric, solves this problem. It has a new central aspheric optic with an extended near vision segment, thus smoothing transition zones.

Upon analysis of my results in the first 10 eyes (five patients) I implanted with the Mplus Xtoric IOL, the mean correction was 0.25 D. At 3 months, the mean decimal distance UCVA was 0.78 and the mean decimal distance BCVA was 0.82. Additionally, intermediate and near visual acuities were 0.72 and 0.87, respectively.

On a scale of 0 to 100, with 0 being not bothersome and 100 being severely bothersome, patients rated glare under 20 and halos under 30.

### COMPARING THE RESULTS

I recently compared my first results with the Mplus Toric and Mplus Xtoric IOLs. In the Mplus Toric group, 20 eyes (13 patients) were included. The IOL power ranged from 8.38 to 27.63 D, and sphere and cylinder ranged from -12.00 to 5.00 D and 1.71 to 4.25 D, respectively. The mean age was 58 years, and the mean correction was -0.53 D.

In the Mplus Xtoric group, the IOL power ranged from 10.98 to 28.84 D, and sphere and cylinder ranged from -14.50 to 5.50 D and 1.75 to 4.04 D, respectively. The mean age was 52 years. At 3 months, both groups had achieved the same distance UCVA of 0.78 and nearly the same distance BCVA (Mplus Toric, 0.83; Mplus Xtoric, 0.82; Figure 1). They had also achieved similar intermediate vision (Mplus Toric, 0.70; Mplus Xtoric, 0.72); however, the near vision was better in the Mplus Xtoric group (Mplus Toric, 0.81; Mplus Xtoric, 0.87).

All patients in the Mplus Xtoric group and 70% in the Mplus Toric group were completely spectacle independent, and only 25% of patients in the latter group required glasses for small print. In the end, 100% of patients were satisfied with their optical results with the Mplus Xtoric and 92% with the Mplus Toric.

A defocus curve for two patients who received the

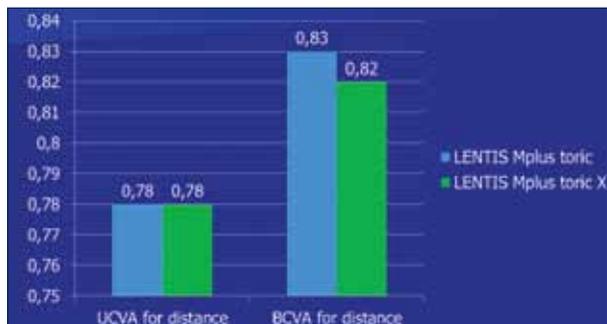


Figure 1. Three-month distance UCVA and BCVA results with the LENTIS Mplus Toric and Mplus Xtoric IOLs.

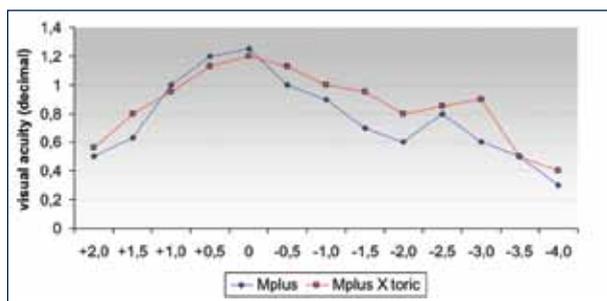


Figure 2. Defocus curves for two patients who received the Mplus Toric IOL in one eye and the Mplus Xtoric IOL in the other.

Mplus Toric IOL in one eye and the Mplus Xtoric IOL in the other is depicted in Figure 2. These patients achieved excellent far vision with both IOLs but better intermediate and near visual acuities with the Mplus Xtoric. Additionally, there was a greater focal range (up to -3.00 D, or 33 cm) with the Mplus Xtoric IOL.

### CONCLUSION

The Mplus Xtoric IOL provides good visual acuity for all ranges of vision. In comparison with the first-generation LENTIS Mplus IOL, the near visual acuity has improved with the Mplus Xtoric, and my patients no longer require spectacles for reading small print or computer use.

Additionally, because of the reduction in the incidence of glare and halos with the Mplus Xtoric IOL in comparison to some rotationally symmetric multifocal IOLs I have previously implanted, I am able to implant the Mplus Xtoric lens in my demanding male patients. The improvement in near visual acuity that this lens provides makes it a great choice for my female patients as well. As a result, I am now able to offer one lens—the LENTIS Mplus Xtoric IOL—to all of my patients, regardless of gender.

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PERSONAL EXPERIENCE WITH THE LENTIS MPLUS XTORIC IOL

By Ludger Hanneken, MD; and Ruediger Schmid, MD, FEBO

1. What is your experience with the current LENTIS Mplus?

**Dr. Hanneken:** Although my experience with the LENTIS Mplus is limited, patients who have received the lens to date are generally happy. They are spectacle independent in nearly all situations, both during the day and night, and have no complaints of optical side effects. Thus far, I have limited implantation to patients who do not have to work a lot on a computer.

**Dr. Schmid:** In my opinion, no other IOL on the market shows as little visual disturbance as the LENTIS Mplus. Our studies with the Ginsburg Box (VSCR-CST-6500; Vision Science Research Corp.) demonstrated good contrast sensitivity in all patients who received the LENTIS Mplus. Only in mesopic conditions, the performance of the IOL was lower than the normal range. According to answers from a standardized questionnaire, only some patients experienced disturbances with photic phenomena (halos and glare). For most patients, these were not relevant.

Additionally, night driving is no problem for most patients, and most patients reported no problems switching between the intermediate and near distances. However, when reading or doing near work, usually more light is needed. We make sure to tell this to our patients prior to surgery. All in all, clinical results with the LENTIS Mplus are convincing. For daily life, glasses are usually not needed.

2. What is your current lens of choice for presbyopia correction?

**Dr. Hanneken:** I had been implanting many nontoric trifocal and low-add bifocal toric IOLs. Postoperative results and patient satisfaction supported their use as a good solution for providing a high degree of spectacle-free vision; however, I noticed drawbacks. Some patients complained about difficulties in low light conditions, and others complained about halos even after the neural adaptation period. Therefore, I recently tried the new LENTIS Mplus Xtoric IOL. Thus far, my results have been promising.

**Dr. Schmid:** I prefer implanting a multifocal IOL to using a monovision approach. Although monovision works with leisure activities, it is usually insufficient for office work. Besides my standard multifocal IOL, the LENTIS Mplus, the AT LISA trifocal (Carl Zeiss Meditec) seems to be an interesting solution, especially for office work. However, even more light for reading might be necessary with a trifocal lens.

3. How do you rate your first results with LENTIS Mplus Xtoric?

**Dr. Hanneken:** I only have implanted the new version of the LENTIS Mplus Xtoric in a small number of patients due to the short time of the lens' availability. With that said, now I suggest this lens quite often, especially to younger, active patients who desire refractive surgery or are in the presbyopic

**“In my opinion, no other IOL on the market shows as little visual disturbance as the LENTIS Mplus.”**

**– Ruediger Schmid, MD, FEBO**

age. I am impressed with the wide range of customizable correction possible with the LENTIS Mplus Xtoric, and patients like the fact that they will receive “their” lens.

Results have been impressive, and patients with high hyperopia and myopia are able to achieve near emmetropia. Consequently, my patients have been extremely happy. I have not noticed any problems with rotational stability within the limited postoperative observation time.

**Dr. Schmid:** The LENTIS Mplus Xtoric works well. The plate haptics keep the IOL stable in the capsular bag, with at most 5° of mean rotation. I implant the LENTIS Mplus Xtoric IOL without the aid of an ophthalmic viscosurgical device, and this improves the immediate adherence of the IOL to the posterior capsule. Additionally, I find that an incision size below 2.2 mm helps me to achieve a precise outcome. The first results with the Mplus Xtoric are promising.

4. Has overall patient satisfaction improved with the new LENTIS Mplus Xtoric?

**Dr. Hanneken:** So far, I do not have any patient who has received this lens and who is not satisfied with the result of his or her surgery. This encourages me to use the LENTIS Mplus Xtoric more frequently.

**Dr. Schmid:** The new IOL design seems to improve intermediate vision and minimize the incidence of halos and glare, especially with large pupils in younger patients. As another important point, the near segment works well in eyes with small pupils, which is common in cataract patients. Patients already had no major complaints with the LENTIS Mplus, but with the new Mplus X lens design, patient satisfaction seems to be even higher. The LENTIS Mplus Xtoric is a great tool for our presbyopic patients to achieve spectacle independence.

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# Initial Clinical Evaluation of the LENTIS Comfort IOL

This lens is appropriate for demanding cataract patients who desire more than standard results.

BY DETLEF HOLLAND, MD

The LENTIS Comfort IOL is based on the LENTIS IOL platform (Oculentis GmbH), providing patients with an extended depth of field. Like the LENTIS Mplus IOL, the LENTIS Comfort has an additional segment in the inferior portion of the lens optic. Differentiating the LENTIS Comfort from the Mplus is a lower dioptric add power: a 1.50 D addition in the Comfort, in contrast with the 3.00 D addition of the Mplus. Otherwise, the design of the IOL is similar to that of the other models in the LENTIS family of IOLs, featuring a 6.0-mm posterior-aspheric optic with a 360° sharp edge. The hydrophilic acrylic material, with a hydrophobic surface, is capable of fitting through a 2.0-mm incision with the appropriate injector.

The segmental add zone focuses a portion of incoming light to a point in front of the retina and the rest of the light is focused to the fovea with minimal light loss (about 7%). Both focal points are on the same optical axis of the IOL. Patients adapt quickly to the vision provided by this IOL due to the minimal halos and glare generated by the optic design and to the natural contrast it provides.

## FOR CATARACT AND REFRACTIVE SURGERY

The LENTIS Comfort IOL can be used for many patients in a cataract and refractive surgery practice. With its low add, it is a unique IOL that bridges the gap between monofocal and multifocal; we consider it a *monofocal-plus IOL*.

The main aim of this IOL is to provide a combination of excellent far and intermediate vision (Figure 1). The goal is not to give the patient perfect near vision, but rather to improve the depth of field compared with a monofocal IOL. It is a good IOL choice for patients who do not mind wearing reading glasses in certain circumstances, such as for reading small type or reading for an extended period.

## FIRST CLINICAL RESULTS

We reviewed our results with the LENTIS Comfort IOL in the first 50 eyes of 25 patients we implanted with the lens. All were cataract patients with no astig-



Figure 1. The LENTIS Comfort IOL provides patients with sharp distance vision and good intermediate vision (A), compared with a standard lens that only provides sharp distance vision and requires reading glasses or varifocal lenses for near vision (B).

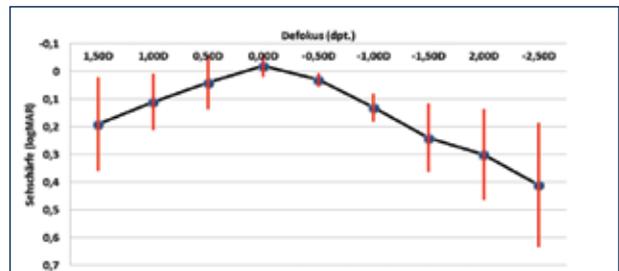


Figure 2. The binocular defocus curve after implanting the LENTIS Comfort IOL.

matism greater than 1.00 D and no other ocular pathology. Average age was 70 years, and all patients were implanted bilaterally and operated with a microincision cataract surgery (MICS) technique. The target refraction was between -0.25 and -0.50 D, in order to attempt good near vision and an acceptable balance between far and near vision.

Postoperative refractive outcomes in terms of UCVA were close to the targeted refraction. After 3 months, for distance vision, mean binocular UCVA was 0.00 logMAR; for intermediate vision, mean binocular UCVA was 0.16 logMAR. Despite the low add power of the LENTIS Comfort, the near vision results were surprisingly good; J4

COMMENT FROM DETLEV R.H. BREYER, MD

My most interesting and thrilling project is a combination I call *Comfort Blending Vision*. This comprises implantation of the LENTIS Comfort IOL in both eyes with a target refraction of 0.00 D in the dominant eye and -1.50 D in the nondominant eye. This idea was born from a patient's request—a hunter who wanted to hunt spectacle free. As he was mainly hunting deer, he depended on excellent vision near, intermediate, and far vision, especially in dim light conditions (dusk and dawn).

The above-mentioned Comfort Blending Vision perfectly met his demands. He is the first of many hunters to see me for cataract surgery.

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DISCUSSION AND CONCLUSIONS

Our initial clinical results demonstrate that the LENTIS Comfort IOL is an excellent alternative to monofocal lens implantation in cataract surgery. This monofocal-plus IOL provides excellent intermediate vision and acceptable near vision; many patients achieve total spectacle independence, even for reading. We hope to improve our subsequent results, especially for near vision, by using micro-monovision.

The LENTIS Comfort IOL is a versatile tool for any cataract and refractive surgeon's armory. Its optic design provides high-quality optical performance with low light loss, no contrast sensitivity loss, and a low degree of halos and glare. The IOL is easy to handle, can be implanted using a MICS technique, and provides a high degree of patient satisfaction.

In our experience, the LENTIS Comfort IOL is appropriate for the demanding cataract patient who wishes to achieve more than the standard result, with a high degree of spectacle independence after surgery. The IOL provides excellent far and intermediate vision, and it is possible to use micro-monovision to improve the reading capability of the patient's overall bilateral optical system.

*Detlef Holland, MD, is a cataract and refractive surgeon at the Augenklinik Bellevue, Kiel, Germany. Dr. Holland states that he has no financial interest in the products or companies mentioned. He may be reached at e-mail: d.holland@augenklinik-bellevue.de.*



with unilateral implantation, 0.39 logMAR near visual acuity 3 months after the second IOL was implanted. The defocus curve shows the remarkable range of vision with the LENTIS Comfort IOL (Figure 2).

In this series of uncomplicated cataract surgeries, there was a high rate of postoperative patient satisfaction and a great degree of spectacle independence; correction was prescribed only for reading and usually no more than 1.50 D for reading small type. There were no subjective complaints of visual phenomena in this series, even in low contrast lighting situations.

# The LENTIS T<sub>plus</sub> X IOL

A new incisionally customized toric solution.

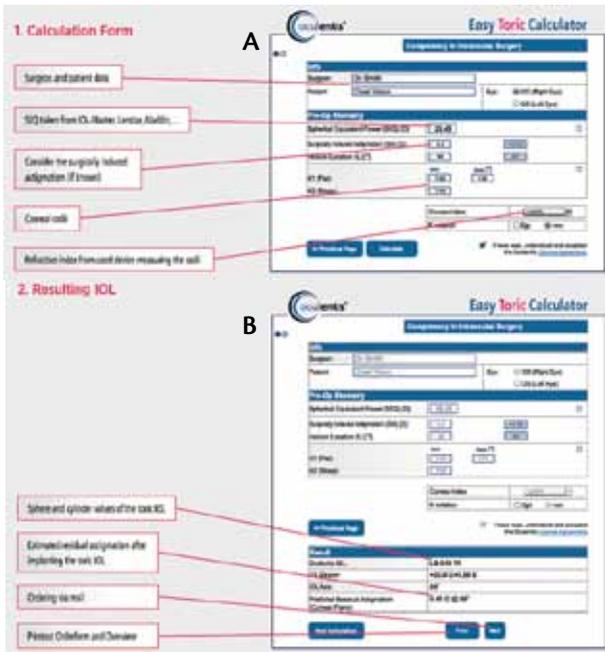
BY FLORIAN T.A. KRETZ, MD, FEBO

Some of the highest standards in today's IOL manufacturing industry are set by Oculentis GmbH. Its LENTIS line of IOLs is aberration neutral, providing patients with better depth of focus, and its optics provide exceptional visual quality and natural high contrast and color perception. The LENTIS IOLs are also designed with a 360° sharp optical edge to prevent posterior capsular opacification and a plate-haptics design that ensures high rotational stability.

The latest breakthrough announced by Oculentis at the 2013 ESCRS meeting in Amsterdam is a toric IOL that is customized to the individual needs of the ophthalmic surgeon, thus eliminating the need for any complicated realignment of the lens in situ. Now, the

torus of the LENTIS T<sub>plus</sub> X IOL is manufactured with a unique incision-dependent approach, whereby the lens is manufactured with the IOL torus appropriately placed on the anterior surface according to the surgeon's preferred incision location. Also, an individualized amount of surgically induced astigmatism can be included in the calculation depending on the surgeon's needs. This lens replaces the customized LENTIS T<sub>plus</sub> (LU-313T), but it still includes individually manufactured cylinder up to 12.00 D to ensure the same outstanding astigmatic correction as the previous lens design.

For the surgeon, the new design of the LENTIS T<sub>plus</sub> X translates into a simplified surgical process. Handling and implanting the IOL is easier, the lens' behavior in situ is



**Figure 1.** On the first screen, the surgeon enters his or her actual amount of surgically induced astigmatism and preferred incision location (A). An order form with precise toric IOL parameters is generated (B).

more predictable, and the time it takes to rotate the IOL into position is greatly reduced. As intracapsular rotation of the lens is nearly eliminated, zonular stress can be reduced. Additionally, just like the other IOLs in the LENTIS line, the Tplus X IOL is extremely stable in the capsular bag.

For the patient, implanting the LENTIS Tplus X IOL translates into individual and highly accurate astigmatism correction, to precisely 0.01 D, and natural high contrast sensitivity and color perception. Additionally, an optional violet light-filter technology is available to improve retinal protection.

**EASY TO ORDER**

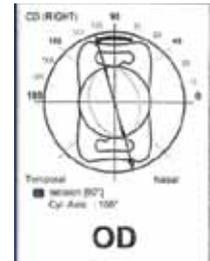
Customizing the LENTIS Tplus X IOL is easy, thanks to the Oculentis Toric Lens Calculator tool, which is available at [www.lentistoric.com](http://www.lentistoric.com). Once on the webpage, the surgeon enters his or her actual amount of surgically induced astigmatism and preferred incision location (Figure 1A). After completing these steps, an order form with the precise toric IOL parameters is generated (Figure 1B). The order is then placed by returning the signed order form via fax or e-mail.

With the appropriate amount of cylinder manufactured at the anterior surface of the lens, the surgeon can enjoy easy implantation and positioning in situ. For example, if the surgeon’s preferred incision location is 110° and the patient’s steep corneal axis is at 70°, the surgeon implants the customized LENTIS Tplus X IOL at 110°, and, without needing to rotate the IOL, the cylinder will be corrected at 70°.

The most important element of this process is to ensure that the surgeon’s amount of surgically induced astigmatism as well as his or her preferred incision location are entered into the online tool accurately.

**CASE REPORTS**

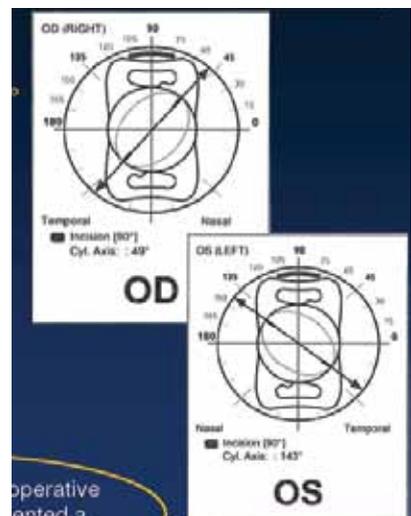
**Case No. 1.** A 72-year-old woman presented for cataract surgery with an ocular history that included strabismus surgery in 1949 and suspected amblyopia in her right eye. Preoperatively, her distance UCVA and BCVA were both 1.3 logMAR in her right eye, with -5.46 D of cylinder at 15° as measured with the IOLMaster (Carl Zeiss Meditec). Distance UCVA and BCVA in the patient’s left eye were 0.72 and 0.02 logMAR, respectively, with -1.47 D of cylinder at 170°. We decided to perform cataract surgery and implant the LENTIS Tplus X in her right eye only.



**Figure 2.** In the patient from case No. 1, the IOL was ordered with an incision location of 90° and the cylinder axis at 106°.

I ordered the appropriate IOL online, with my preferred incision location of 90° and the axis of cylinder at 106° (Figure 2), and surgery was scheduled for September 2013. On postoperative day 1, the patient’s distance UCVA improved to 0.72 logMAR; however, some corneal edema was present and the intraocular pressure (IOP) was 18 mm Hg. By postoperative day 3, the distance UCVA further improved to 0.1 logMAR, there was no longer any sign of corneal edema, and IOP dropped to 17 mm Hg. The patient was extremely satisfied with her visual results. During follow-up over 3 months, visual acuity and IOP stayed stable.

**Case No. 2.** A 63-year-old man presented for cataract surgery with bilateral hyperopia and astigmatism. Preoperatively, his distance UCVA was finger counting, his distance BCVA was 0.14 log-MAR, and his refraction was 8.00 -2.00 X 132° in his right eye. Distance UCVA and BCVA in his left eye were



**Figure 3.** In the patient from case No. 2, two IOLs were ordered, the first with an cylinder axis at 49° and the second with a cylinder axis of 143°.

finger counting and 0.32 logMAR, respectively, and his refraction was 8.00 -3.50 X 53°. As measured by the IOLMaster, he had -2.39 D of corneal astigmatism at 145° in his right eye and -3.27 D at 49° in his left. We decided to perform cataract surgery and implant the LENTIS Tplus X bilaterally. I ordered two IOLs, one with a cylinder axis of 49° for the right eye and one with a cylinder axis of 143° for the left (Figure 3). On the first postoperative day, the patient's distance UCVA had improved to 0.04 logMAR, and his IOP was 13 mm Hg. Over the follow-up period of 3 months, UCVA stabilized at 0.00 logMAR, and IOP was between 12 and 14 mm Hg.

### CONCLUSION

The LENTIS Tplus X is the first toric IOL to offer an individual toric plane that is dependent on the surgeon's preference for incision placement as well as his or her individual

amount of surgically induced astigmatism. This results in an easier surgical procedure and avoids the need for intraoperative rotation of the IOL.

Like the other LENTIS IOLs, the Tplus X has good rotational stability, with less intraoperative zonular trauma. Thus far in my experience, I have had successful postoperative outcomes with high patient satisfaction.

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# Laser-Assisted Cataract Surgery and the LENTIS Laser Lens

A 4.8-mm capsulotomy is ideal.

BY JULIAN D. STEVENS, MRCP, FRCS, FRCOPHTH

As surgeons, we continually strive to develop the experience and skills we need to be as consistent and precise as possible and to achieve the best possible postoperative outcomes. For cataract surgery, we have been able to achieve excellent results using ultrasound phacoemulsification, but it is 46 years since Anton Banko and Charles D. Kelman, MD, patented this. Now, with femtosecond laser systems for cataract surgery, there is another revolution in the degree of surgical planning and precision that we can consistently achieve.

### PLANNING THE CAPSULOTOMY

As we develop use of femtosecond cataract technology, we are discovering it has benefits for many key steps of cataract surgery, including planning the capsu-

lotomy size, shape, and position and being able to plan lens centration. The big debate will be where to center the capsulotomy, whether it is over the undilated preoperative pupil, line of sight, the geometric center of the capsular bag, or the apex of the cataractous lens capsule. My own preference is over the undilated pupil, but future clinical trials will formally determine what is optimum in both short- and long-term. Having a femtosecond laser enables placement of the capsulotomy in any location.

One benefit of femtosecond lasers is that they allow us to design a capsulotomy according to the size of the IOL being implanted as well as the desired final coronal (X-Y) position of the lens. We can also create a particular capsulotomy shape with the femtosecond laser, including circular, elliptical, or a custom shape. A notch

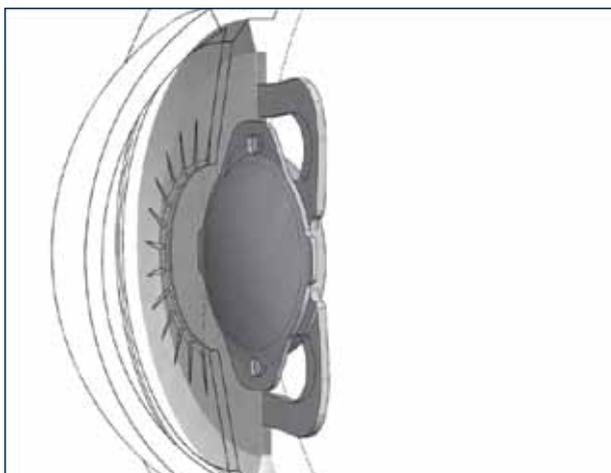


Figure 1. The LENTIS Laser Lens design allows fast and easy capture of the capsulotomy.

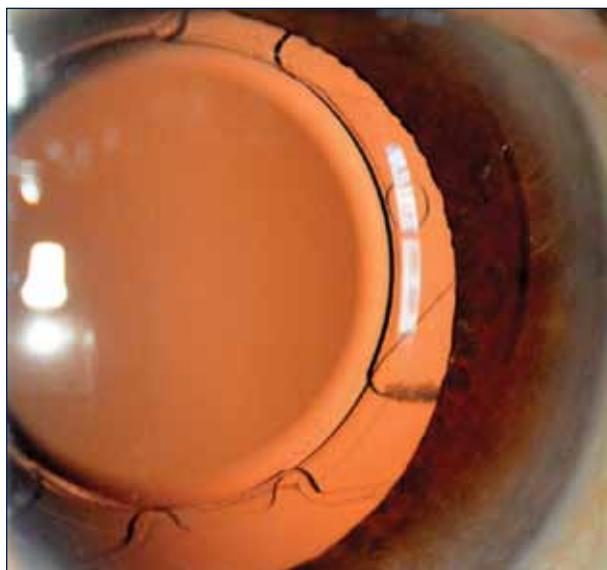


Figure 2. The LENTIS Laser Lens is held in centration by the anterior capsulotomy.

to aid with astigmatism meridian alignment or micro-femtotomies can be created.

### CENTERING THE LENS OPTIC

An IOL's haptics are designed to help lens centration over the desired location. As the lens moves within the capsular bag, it is the role of the haptics to ensure that the lens optic remains geometrically centered. It is natural, however, for the capsular bag to have a small amount of inherent tilt or decentration with respect to the entrance pupil. This does not significantly affect results until the decentration reaches approximately 0.15 or 0.20 mm, at which point coma can become optically symptomatic.

The ideal capsulotomy size is unknown. Currently my preference is for a 4.8-mm diameter, which creates a 0.6-mm overlap for a 6.0-mm diameter lens optic. Today, femtosecond laser platforms for cataract surgery can be used to help surgeons reliably create near-perfect capsulotomies. Advancing IOL designs with aspheric low-aberration optics combined with laser-assisted cataract surgery can help surgeons to improve their postoperative outcomes even further.

### LENTIS LASER LENS DESIGN

A new proposed lens design includes a groove into the edge of the lens optic that is designed for the capsulotomy to plug into. A notch at the edge of the optic drains the capsular bag, thereby preventing capsular bag distention syndrome. Such a lens design prevents ophthalmic viscosurgical device (OVD) becoming trapped behind the lens optic and any osmotic inhibition from occurring.

In addition to a groove, the modified femtosecond laser-specific LENTIS Laser Lens (Oculentis GmbH) is designed with two larger flaps along the longitudinal section and two little flanges along the latitudinal section of the IOL to allow fast and easy capture of the capsulotomy (Figure 1).

My average time to deliver and implant the LENTIS Laser Lens is approximately 20 to 30 seconds. After it is implanted, I press back slightly to take out any methylcellulose, thus avoiding any trapped material in the capsular bag, and flip the four flanges in front of the anterior capsule to hold the lens in place. Subsequently, the IOL is held in centration by the anterior capsulotomy (Figure 2).

### CONCLUSION

With modern IOLs like the LENTIS Laser Lens, laser refractive cataract surgery will become increasingly advantageous, as future lenses will be held in place by the capsulotomy or, at the very least, positioned with respect to the capsulotomy. This design will not only increase precision but lead to better short-term outcomes for our patients.

*Julian D. Stevens, MRCP, FRCS, FRCOphth, is a Consultant Ophthalmic Surgeon at Moorfields Eye Hospital in London. Dr. Stevens states that he is a consultant to Oculentis GmbH. He may be reached at tel: +44 20 7251 4835.*



# The LENTIS Mplus High Add IOL

With an 8.00 D near addition, this lens is a good option for patients with macular degeneration.

BY GERD U. AUFFARTH, MD, PhD, FEBO

Macular degeneration is an extreme burden to our patients. Although a large number of individuals with age-related macular degeneration (AMD) suffer from blurred vision and eventual blindness, nowadays we can use intravitreal injections to maintain an acceptable level of visual acuity for daily activities. However, the need for cumbersome visual aids including magnifying spectacles, electronic reading desks with inverse letters, or transportable reading desks still exists.

Very recently, Oculentis introduced the LENTIS Mplus High Add IOL. With an 8.00 D near addition, this IOL can be quite useful in patients with AMD because it translates to 6.00 D of near correction on the spectacle plane and has 1.5 times magnifying power. This aspheric multifocal IOL has a biconvex optic with a sector-shaped near addition; its overall length is 11.0 mm and its optic size is 6.0 mm.

## FIRST CASE: GOOD RESULTS

We implanted our first LENTIS Mplus High Add IOLs in late September 2013 in a 68-year-old woman with dry AMD in her right eye and exudative AMD in her left. Normally this lens would be implanted unilaterally; however, with scotoma and cataract present in both eyes, in this case we decided to implant the IOL bilaterally. The patient presented with decent visual acuity in her right eye but poor visual acuity, even corrected, in her left eye.

At the preoperative exam, distance UCVA in her right eye was 0.82 logMAR, with a refraction of 0.50 -1.00 X 180° and a distance BCVA of 0.62 logMAR. With a near addition of 6.00 D, the patient could achieve a near BCVA of 0.4 logMAR (15 cm); however, she required 10 to 15 times magnification with a video magnifier for near vision tasks. In her left eye—the eye with wet AMD—the patient's distance UCVA was 2.0 logMAR with a refraction of 0.00 -1.25 X 180°. In this eye, her distance BCVA was only 1.3 logMAR. Optical

coherence tomography (OCT) images of the right and left eyes are shown in Figure 1.

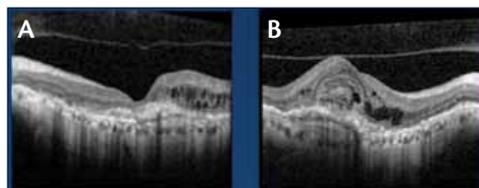


Figure 1. OCT images in the right (A) and left (B) eyes of a 68-year-old patient undergoing bilateral implantation of the LENTIS Mplus High Add IOL.

Having an 8.00 D near add has not changed the form of the LENTIS Mplus High Add IOL, and it centers in the same fashion as a standard Mplus. Therefore, my implantation technique in this case was my standard technique for the Mplus IOLs. I did, however, push the lens out of the injector and into the capsular bag more carefully than usual, to avoid tearing the optic in my first attempt at implantation.

Follow-up was scheduled for 1, 5, and 7 days postoperatively. On day 1, some signs of corneal edema were noted, but the patient was extremely happy with her visual quality at distance and near and felt that her functional vision was greatly improved.

One day postoperatively, distance and near UCVA in the patient's right eye were already 1.3 logMAR and 0.6 logMAR (13 cm), respectively. She still required a video magnifier for near tasks, but only with 2.5 times magnification power to read the newspaper and 6.0 times magnification power for comfortable reading at 13 cm. In her left eye, distance UCVA was 1.3 logMAR and near UCVA was 1.0 logMAR at 13 cm.

Four days later, distance UCVA improved to 1.02 logMAR, with a refraction of 0.00 -0.50 X 175° and a distance BCVA of 0.82 logMAR. For near vision, her UCVA was 0.8 logMAR at 13 cm, and she only required 2.5 times magnification power for reading newspaper-size print at a distance of 13 cm. We also had the patient use the Salzburg Reading Desk, which can

automatically measure the distance that the patient is reading at. At a distance of 10 cm, she was able to read 43 words per minute, which is good for an AMD patient.

### TAKE-HOME MESSAGE

Normally, I would not implant this IOL in both eyes at the same time, but, because of the big difference in visual acuity from the dry and wet AMD in this patient, we were pretty sure that she could only see monocularly for near vision. Now, with two LENTIS Mplus High Add IOLs implanted, her binocular reading is good. She has no problems with distance and near vision or with photic phenomena including glare. She also feels more comfortable performing daily tasks.

Subjectively, bilateral implantation of the LENTIS Mplus High Add IOL helped this patient to achieve better distance and near visual acuity and more independence in daily life. Objectively, there was no incidence of double vision or photic phenomena including halos, no compromised distance visual acuity, and the patient adapted quickly to the near addition.

### CONCLUSION

The LENTIS Mplus High Add IOL is most suitable for patients with stable macular disorders with a minimum visual acuity of 1.0 logMAR and a maximal estimated visual acuity of 0.5 logMAR. Although monocular implantation is recommended, we did have successful results with bilateral implantation in the case presented above.

I believe that this lens is a good option to explore in many patients suffering from AMD, as long as the disease is stable. There are no negative side effects associated with implanting the LENTIS Mplus High Add IOL, and I think it can bring patients comfort and independence from external vision aids.

*Gerd U. Auffarth, MD, PhD, FEBO, is the Chairman, Department of Ophthalmology, University of Heidelberg, Germany. Professor Auffarth states that he has no financial interest in the products or companies mentioned but has received research grants, lecture fees, and/or travel reimbursement from Oculentis. He may be reached at e-mail: ga@uni-hd.de.*



# The myLENTIS Principle

The future of monofocal refractive cataract surgery is individual correction of all aberrations.

BY MANFRED R. TETZ, MD

Oculentis has recently incorporated new refractive principles into many of its existing IOL designs. Of the models now available, those with low- and high-power additions look especially promising, with the latter being indicated for patients with age-related macular degeneration. Another innovation from Oculentis—one that I find interesting—is the myLENTIS. This concept is described below in detail.

Our aim as surgeons is to correct more than just spherical error, and therefore today the current state-of-the-art for monofocal refractive cataract surgery is the toric IOL. Achieving corrections in the range of lower-order aberrations is extremely desirable, and today premium toric lenses such as the LENTIS Tplus (Oculentis GmbH) account for approximately 10% to 15% of the available monofocal designs.

But what about higher-order aberrations (HOAs)?

We know that eliminating spherical aberration pro-

vides patients with better image quality. Historically, surgeons have tried to achieve this by implanting a lens with  $-0.27 \mu\text{m}$  of spherical aberration—the average amount of spherical aberration found on a typical cornea. However, we also know that corneal spherical aberrations varies widely from patient to patient, with some having  $0.1 \mu\text{m}$  and others having  $0.4 \mu\text{m}$ . Therefore, as our patients become more demanding, the strategy of implanting a lens with a preset amount of spherical aberration is insufficient.

The future of monofocal refractive cataract surgery is individual correction of all aberrations. This, indeed, is the myLENTIS principle: a lens design that allows individual correction of spherical aberration made for a specific patient. In order to individually correct corneal spherical aberration and, thus, leave the optical system without any spherical aberration, the surgeon must measure the individual corneal aberration in each

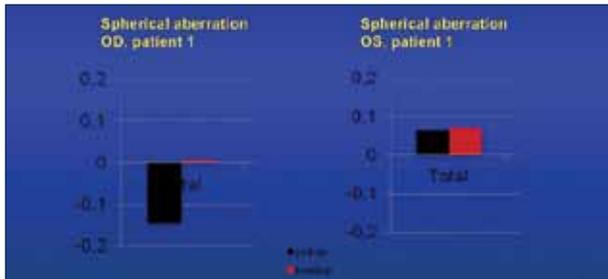


Figure 1. Pre- (black) versus postoperative (red) total spherical aberrations in the right and left eyes of one patient treated in Düsseldorf, Germany.

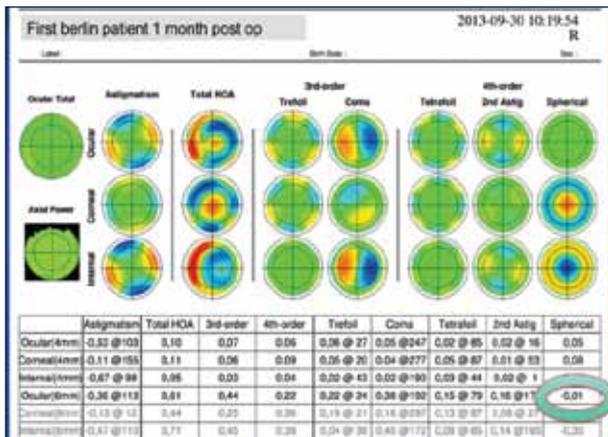


Figure 2. One-month follow-up data from the first patient participating in Berlin.

patient, the data must be sent to the company, and the company must custom make the IOL.

### CURRENT STUDY

A prospective multicenter European study is currently under way to compare the improvement in image quality after HOA correction with the customized myLENTIS IOL with that of a standard IOL. This single-arm, intraindividual comparison is randomized and double-blind with concealment. A total of 10 to 15 patients (20 to 30 eyes) were enrolled at each of five centers in Berlin, Germany; Alicante, Spain; Poznan, Poland; Mainz, Germany; and Düsseldorf, Germany and received the myLENTIS in one eye and a standard IOL in the other. Postoperative analyses are performed using the KR-1W (Topcon Europe Medical B.V.). At the time of this

publication, 10 eyes have at least 1-month follow-up. Although the final data is not yet available, the below two examples demonstrate the excellent results we have seen to date at all of the participating centers.

**Example No. 1.** Figure 1 shows a wavefront analysis of the total pre- and postoperative spherical aberrations in a patient who underwent surgery in Düsseldorf. Although this is a double-blind study, and officially we do not know which IOL was implanted in each eye, it is quite obvious which eye received the myLENTIS IOL.

**Example No. 2.** Figure 2 shows 1-month follow-up data from our first patient participating in Berlin. Again, we do not officially know which eye received the myLENTIS IOL. However, we can see the measurements of spherical aberration, ocular spherical aberration, corneal spherical aberration, internal spherical aberration, and total ocular aberration, and they are impressive. Additionally, when ocular aberration at a 6.0-mm zone is taken into account, the calculation of spherical aberration is nearly zero (-0.01).

### CONCLUSION

Early evidence on the myLENTIS principle is encouraging for two key reasons. First, Oculentis can make these specific, individualized myLENTIS IOLs with precision, and second, with the two cases detailed above, we seem to be able to show measurable reduction in the total spherical aberration of an optical system. We hope that, in the next couple of years, we have more promising data to report.

Should the study result in positive proof of principle, the most popular applications for this lens are for post-LASIK patients and for inducing depth of field for presbyopia correction, correcting extreme aberrations or nonprogressive keratoconus, and correcting aberrations in case of high anisometropia.

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