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Three tipping points in refractive cataract surgery

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New frontiers in presbyopia correction

Ronald Yeoh, MD

New extended range of vision intraocular lens offers new option for presbyopic patients

Refractive cataract surgeons continue to seek techniques and technologies that will eliminate the need for glasses after surgery.

The "holy grail" of cataract surgery is enabling patients to see at both distance and near at the same time, said **Ronald Yeoh, MD**, adjunct assistant professor, Duke-NUS Graduate Medical School, Eye and Retina Surgeons Singapore, Singapore National Eye Centre, National University Hospital, Singapore, during a symposium on refractive cataract surgery presented at the Asia-Pacific Association of Cataract & Refractive Surgeons (APACRS) annual meeting in August 2015 in Kuala Lumpur, Malaysia.

Surgeons strive to achieve a full range of vision by turning to a variety of intraocular lenses (IOLs)—multifocal IOLs, accommodative IOLs, monovision, and recently launched extended range of vision IOLs.

Mini monovision

Target	Achieved	NVA	Rating
Pl & –0.84	pl/–0.25	N6	4
Pl & –0.8	+0.625/–0.375	N5	4.5
–0.23 & –1	–0.375/–1.375	N5 6/18	3.5
–0.24 & –0.98	–0.125/–0.75	N4	5

Average rating: 4.25

Figure 1. Mini-monovision results after bilateral implantation of the Symfony IOL

Both eyes low myopic correction

Target	Achieved	NVA	Rating
–0.4 & –0.2	–0.4 & –0.35	N5	5
–0.6 & –0.2	–1.5 & –0.25	N5 6/18	4
–0.2 & –0.4	–0.25 & –0.25	N5	5
–0.4 & –0.5	–0.125 & plano	N5	4.5
–0.2 & –0.38	–0.25 & –0.75	N4	4
–0.3 & –0.6	–0.625 & –1.125	N5 6/12	4
–0.3 & –0.5	–0.375 & –0.75	N5	5

Average rating: 4.5

Figure 2. Results after bilateral implantation of the Symfony IOL when both eyes had a low myopic correction

Although multifocal IOLs work reasonably well, patients still cope with issues such as glare and halos, he said. In addition, there is loss of contrast, and patients' dim light vision is suboptimal.

As a result, patients considering these options require more chair time, so ophthalmologists can carefully select the best candidates and explain the risks. Surgeons

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also need a strategy to handle unhappy multifocal IOL recipients, Dr. Yeoh said.

Approximately 30% of Dr. Yeoh's cataract surgery patients have multifocal IOLs; therefore, 70% of patients would require reading glasses.

He also uses monofocal monovision in some patients. However, this option has some limitations, he explained. Patients need glasses for nighttime driving and reading small print. Dr. Yeoh usually prescribes progressive glasses as backup.

New IOL technology

The Tecnis Symfony extended range of vision IOL (Abbott Medical Optics, Abbott Park, Ill.) uses two complementary enabling technologies, he said. The echelette design uses a concept of diffraction to elongate the depth of focus and extend the range of good vision. Because there is only one extended focal point, he explained, it obtains approximately 90% light transmission versus the 40–50% that full multifocal IOLs get to each focus. The achromatic technology reduces chromatic aberration for enhanced contrast sensitivity and quality of vision.[1]

The Symfony extended range of vision IOL provides a sustained mean visual acuity of 20/20 or better through 1.5 D of defocus, as well as a full range of functional vision (20/40 or better) through 2.5 D of defocus, he said.[2] The incidence of halo and glare are similar to that of a monofocal IOL.[2]

Dr. Yeoh said that the Symfony extended range of vision IOLs are useful for low myopes, in unilateral implantation, for modified monovision, and for patients who had a monofocal IOL previously and would like near vision (without a full multifocal IOL).

Lens experience

Dr. Yeoh shared early results from his experiences with the Symfony extended range of vision IOL.

He performed bilateral implantations in 20 patients, with follow-up of 1 to 3 months in 11 patients. Eighty-two percent had distance visual acuity of 6/9 or better, but cases that were 6/12 and 6/18 had myopic targets. All patients achieved N6 or better binocular near vision. Patients had a targeted refraction of –0.2 to –1.04 (compared with full multifocal IOLs); in seven patients both eyes were targeted at –0.2 to –0.6 D, and four patients were targeted at plano and –0.8 D.

The mini-monovision group had an average rating of 4.25, and in the group in which both eyes had low myopic corrections, the average rating was 4.5 (Figures 1 and 2).

Monocular Symfony implantation was used in patients who originally had a monofocal IOL in the other eye, were still phakic in the other eye with little cataract, or had pathology in the other eye.

With monocular implantation of Symfony, 77% of patients were 6/9 or better and 69% were N6 or better, with an average rating of 4.4.

> ***"The 'holy grail' of cataract surgery is enabling patients to see at both distance and near at the same time."***
>
> ***–Ronald Yeoh, MD***

Dr. Yeoh summarized his targets for bilateral implantation as follows: He aims for plano/first minus in one eye and –0.75 D in the other or low minus between –0.25 and –0.5 D in both eyes.

His targets for monocular implantation are as follows: If the other eye is plano, he aims for approximately –0.75 D, or if the other eye is not plano, he aims for –0.25 or –0.5 D, depending on how much near vision is desired.

In the last 6 months, Dr. Yeoh has found that quality of vision is not a major issue for these patients. Although they may notice halos or starbursts, they are not usually a problem, but surgeons need to caution patients about this possibility and counsel them.

He has found that it is a forgiving lens; even patients who have –0.75 D outcomes have reasonably good distance vision. He has found that –0.75 D is good for near.

Dr. Yeoh shared the importance of counseling and setting realistic targets. He also explained that binocular vision is better.

For patients who want very good near vision, a full multifocal IOL is still the IOL of choice, especially if patients are hypermetropic or have high myopia with dense cataracts, he said. Otherwise, he thinks it is a very effective tool.

Conclusion

Dr. Yeoh has found that the Symfony IOL provides a reasonable range of vision from intermediate to distance with few side effects. However, he said, for full multifocal vision a full diffractive pseudoaccommodative IOL is still the best choice.

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Keys for optimal astigmatism correction with toric IOLs

Tal Raviv, MD

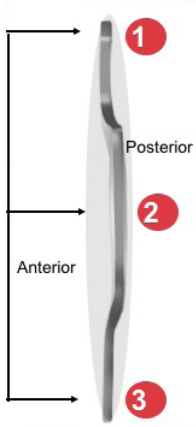
When implanting toric intraocular lenses, surgeons should choose carefully from among available technologies and take important surgical measures

As refractive cataract surgery advances, surgeons need to take key steps to deliver the visual outcomes patients expect.

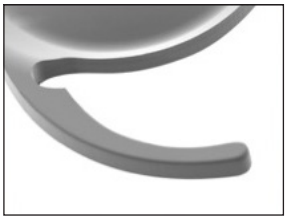
In approximately 50% of cases, surgeons must address astigmatism of 0.75 D or more, said **Tal Raviv, MD**, clinical associate professor of ophthalmology, Icahn School of Medicine at Mount Sinai, and founder and medical director, Eye Center of New York, during a symposium on refractive cataract surgery presented at the Asia-Pacific Association of Cataract & Refractive Surgeons (APACRS) annual meeting in August 2015 in Kuala Lumpur, Malaysia.

When correcting astigmatism with toric IOLs, lens selection and surgical strategies play important roles in dictating the final results.

- **3-point fixation provides:**
  - Constant capsular contact
  - Additional stability over traditional single-piece lenses
- Offset haptic design enables the lens to adhere to the posterior capsule
- Contact of 360° square edge against the posterior capsule enables LECs to close the capsular bag



- **Ease of implantation**
  - Bag-friendly coplanar delivery
  - Reduced center thickness for a slim lens profile additionally facilitates implantation
  - Polished haptic loops reduce friction and enable controlled, gentle unfolding of the lens in the capsular bag



Figures 1 and 2. Key lens design considerations for toric IOLs

Toric IOL selection

Lens quality is a primary concern. "We want a lens that is not going to have glistenings later on, and we know there are some lenses that have risks for developing glistenings," Dr. Raviv said. As the years pass, glistenings can decrease contrast, which becomes more significant as toric IOLs are implanted in patients at earlier ages.

Dr. Raviv said that IOLs should allow full transmission of healthy blue light to provide improved scotopic sensitivity; correct spherical aberration as close to zero as possible to provide sharper vision; and have a high Abbe number and less light dispersion, decreasing chromatic aberration.

Surgeons also need to evaluate lens design. One of the most important factors in toric IOLs is rotational stability, he said. Dr. Raviv explained that three-point fixation provides constant capsular contact and additional stability compared with traditional single-piece lenses (Figure

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1. Steep axis marking – manually on cornea or with digital registration
2. Ensuring good wound construction and 360-degree capsulotomy overlap
3. IOL unfolding and positioning
4. OVD removal under the IOL
5. Confirming proper final IOL position
6. Ensuring watertight wound closure

Figure 3. Six key surgical steps to minimize postoperative rotation

> ***"It is crucial to take these extra steps to get all of our patients on target."***
>
> ***–Tal Raviv, MD***

1). The offset haptic design of the Tecnis Toric IOL (Abbott Medical Optics, Abbott Park, Ill.) permits the lens to adhere to the posterior capsule. Furthermore, 360-degree contact of the square edge against the posterior capsule prevents central migration of lens epithelial cells, he said.

Ease of implantation is also important. Lenses should allow bag-friendly coplanar delivery; have a reduced center thickness, which facilitates implantation; and have polished haptic loops, which reduce friction and enable the lens to unfold in a controlled manner in the capsular bag (Figure 2).

Lens implantation

To minimize postoperative rotation, Dr. Raviv recommended several surgical steps (Figure 3). "It's very important to mark the cornea preoperatively," he said. He explained that a 1-degree rotation will decrease the astigmatic effect of the IOL by 3.3%; a 10-degree rotation will result in a 33% loss of effect; a 30-degree rotation will result in 100% loss of effect; and more than 30 degrees of rotation will induce new astigmatism.

He also emphasized the importance of good astigmatically neutral wound construction and the correct capsulotomy size. "I typically target a well-centered capsulotomy of 5.0 mm, making sure there is a 360-degree overlap over the toric IOL. That is an important factor in making sure there's good rotational and refractive stability," he said.

"We want to have precise positioning of the IOL," he said. Whether using ink markings, digital overlays, or intraoperative aberrometry, every degree counts, he explained.

"In addition, to lock in the lens, surgeons should thoroughly remove OVD under the IOL," he said.

Finally, he said, the surgeon should ensure that the wounds are sealed to prevent anterior or posterior movement. Dr. Raviv has a low threshold for utilizing an ocular sealant.

"Of course, postoperatively we want to make sure we have good results," he said. When desired outcomes are not achieved, surgeons can pinpoint the problem by dilating the pupil and looking at the IOL marks and the intended location of the lens. "There are apps you can use with the toric to determine the new axis of the lens," Dr. Raviv said.

He also uses the Toric Results Analyzer, developed by **John Berdahl, MD**, and **David Hardten, MD** (astigmatismfix.com). "It lets you know whether rotating the IOL is going to make a difference," he said.

Conclusion

To obtain optimal refractive outcomes in patients with astigmatism, cataract surgeons need to consider several factors when choosing an IOL and performing implantation. "It is crucial to take these extra steps to get all of our patients on target," Dr. Raviv said.

Next-generation lens extraction: ideal fragmentation patterns and keys for customizing your phaco settings with LACS

Tal Raviv, MD

Advanced intraocular lens (IOL) and femtosecond laser technology offers surgeons an array of benefits in tailoring cataract surgery to patients' individual needs.

Tal Raviv, MD, clinical associate professor of ophthalmology, Icahn School of Medicine at Mount Sinai, and founder and medical director, Eye Center of New York, discussed customization of laser-assisted cataract surgery (LACS) during a symposium on refractive cataract surgery presented at the Asia-Pacific Association of Cataract & Refractive Surgeons (APACRS) annual meeting in August 2015 in Kuala Lumpur, Malaysia.

"LACS is the newest tool we have, and it certainly represents the present and the future," Dr. Raviv said.

Customization parameters

Surgeons can use LACS to perform corneal incisions, treat astigmatism, create capsulotomies, and fragment lenses. "Fragmentation is divided into both segmenting into actual pieces and softening—a very new concept that we have," he said.

Dr. Raviv uses the Catalys Precision Laser System (Abbott Medical Optics, Abbott Park, Ill.). He explained that it segments and softens the nucleus with minimal gas generation, allows users to adjust grid spacing (100–2,000 μm), and enables fast and easy cortical removal.[1] The laser procedure results in minimal corneal edema and inflammation after surgery and allows customization.[2,3]

Using a touch-screen interface, surgeons choose the type of segmentation and softening they prefer, depending on each case (Figure 1).

Dr. Raviv segments and softens a dense lens, typically using a 350-μm grid. "But for a soft lens, I don't need to segment it," he said. In these cases, he performs a supracapsular procedure, usually using a 500-μm grid.

For a case with a dense lens and small pupil, he segments and softens the central lens and then performs a manual capsulotomy. For a posterior polar cataract, however, he performs a capsulotomy without fragmentation because gas formation during the femtosecond laser fragmentation can end up in the wrong place through the posterior capsular defect, he said.

Fluidics driven

"We've moved from ultrasound-driven to fluidics-driven procedures, and that is the paradigm shift that we are seeing," Dr. Raviv said (Figure 2). The goal of this procedure is not to eliminate phacoemulsification, but to perform a safer, quicker procedure that produces less energy, he said.

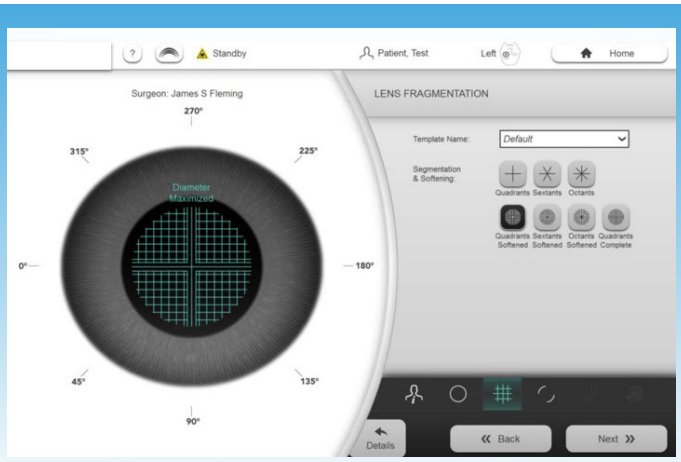

Figure 1. Catalys customization parameters

> ***"We've moved from ultrasound-driven to fluidics-driven procedures, and that is the paradigm shift that we are seeing."***
>
> ***–Tal Raviv, MD***

Dr. Raviv uses the WhiteStar Signature Phacoemulsification System (Abbott Medical Optics), featuring a dual pump that allows surgeons to switch between peristaltic and venturi pumps (Figure 3).

"I can use a different pump for different parts of the procedure," Dr. Raviv said.

The peristaltic pump provides holdability, enabling the surgeon to hold large fragments at the tip. This is recommended for sculpting in manual cases and pulling the first quadrant centrally.

The venturi pump draws small fragments to the tip and

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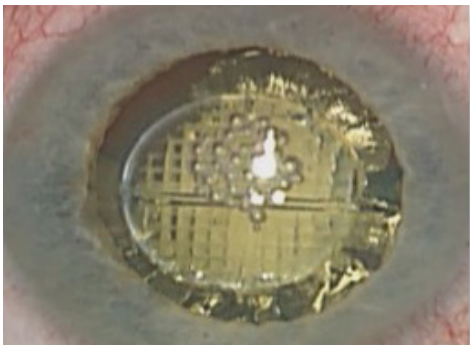
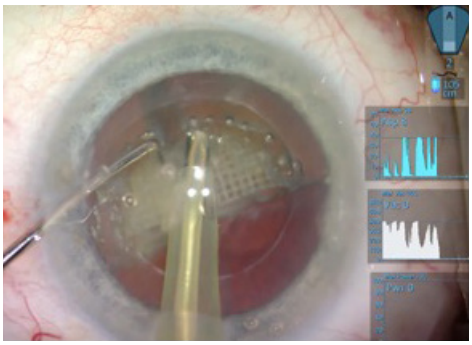


- Designed for laser cataract surgery
- Can soften and segment a lens
- Creates surface maps and safety zones



- Fluidics-driven lens removal
- Fluidics: peristaltic + venturi
- Peristaltic pump provides excellent holdability
- Venturi pump provides excellent followability
- Increased efficiency

Figure 2. Fluidics-driven lens removal

Step	Pump
Sculpt	Peristaltic
1st quadrant	Peristaltic
2nd–4th quadrant	Venturi
Cortex	Venturi

Figure 3. Fluidics settings by intraoperative step

provides increased followability, which may reduce the effective phacoemulsification time. Venturi is excellent for quadrant removal, supracapsular phaco, and I/A, Dr. Raviv said.

"Once we start fragmenting pieces to 350 μm in our traditional phaco paradigm of getting occlusion first, we might not be able to get that occlusion, and that's why venturi becomes more important. That's why I enjoy using the venturi and peristaltic together," he said.

The handpiece technology combines longitudinal and transversal motion, allowing surgeons to cut smoothly, with enhanced efficiency. The transversal component provides additional cutting with shearing action, similar to torsional phacoemulsification. The longitudinal component assists in processing the material through the shaft of the tip, similar to traditional longitudinal phacoemulsification.

Dr. Raviv showed a video clip demonstrating fragmentation of a medium-sized lens with the Catalys system, which transformed it into a very soft lens. "It has allowed me to perform a supracapsular technique on about 60% of surgeries," he said. "I still reserve the chopping technique for dense lenses, but with laser softening, the formerly medium-sized density lens becomes a soft lens, and I can safely emulsify it very expeditiously."

With the OCT guidance, the capsulotomy also can be precisely centered on the lens instead of the pupil, Dr. Raviv added. "LACS provides excellent reproducibility to our surgeries, accuracy that we need to achieve improved and more predictable refractive outcomes," he said.

Conclusion

With LACS, surgeons can customize procedures for all cataract types. They can segment and/or soften the lens, opt for venturi and/or peristaltic modes, and perform phacoemulsification with transversal and longitudinal modes.

Advances in refractive cataract surgery are transforming clinicians' surgical strategies. "With the femtosecond laser we have to change everything we've learned all these years," Dr. Raviv said.

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Pursuing a new level of outcomes with custom laser vision correction

Arvin Chi-Chin Sun, MD, PhD,

Innovative systems offer opportunities to customize refractive surgery to deliver higher-quality visual outcomes

With the evolution of advanced diagnostic and surgical technology, surgeons are taking a new look at the outcome goals they set for refractive surgical procedures.

Uncorrected visual acuity (UCVA) of 20/20 is no longer an acceptable standard for laser vision correction outcomes that will ensure high levels of visual quality and patient satisfaction, said **Arvin Chi-Chin Sun, MD, PhD**, Department of Ophthalmology, Chang Gung Memorial Hospital, Keelung, Chang Gung University, Taiwan, who spoke during a symposium on refractive cataract surgery presented at the Asia-Pacific Association of Cataract & Refractive Surgeons (APACRS) annual meeting in August 2015 in Kuala Lumpur, Malaysia.

New goals

In establishing new goals, Dr. Sun explained, surgeons may want to consider the following parameters: 20/16 UCVA, a ratio of postoperative uncorrected distance visual acuity/corrected distance visual acuity (UDVA/CDVA), contrast sensitivity, and patient satisfaction surveys.

Patient satisfaction after LASIK is highly correlated with UCVA and negatively correlated with visual disturbances and dry eye.[1,2] It is important for surgeons to achieve excellent UCVA with the initial surgery. Patients may be disappointed with 20/20 UCVA.

Dr. Sun explained that surgeons need to perform enhancement surgery to increase patient satisfaction. They need to treat residual refractive error, which is the most common cause of visual disturbances, and reduce glare and halos. Furthermore, they need to aggressively treat dry eye and ocular irritation.

New technology

Dr. Sun discussed whether new technology—such as topography-guided ablation and advanced wavefront-guided ablation—may potentially help surgeons address these goals.

The topography-guided ablation profile combines manifest refraction and corneal topography, he said. It uses Placido disk and Scheimpflug technology and is designed to treat corneal aberrations exclusively. It can be used for primary treatment and therapeutic applications. It also can be used on previously operated symptomatic eyes with decentered ablations, small optical zones, and residual or induced corneal irregularities.

> ***"The latest wavefront-guided technology offers an improved ablation profile based on the optical aberrations in the entire eye."***
>
> ***–Arvin Chi-Chin Sun, MD, PhD***

Dr. Sun described several potential advantages of topography-guided ablations. Surgeons are familiar with topography. The technology offers consistency of capture and less fluctuation without accommodation and centroid shift. Clinicians may choose to use it for corneal aberrations too high for accurate wavefront capture and when they cannot or do not want to perform wavefront-guided ablations.

Advanced wavefront-guided ablation is also a new option.

In 2008, **Steven Schallhorn, MD**, published a review studying the effects of wavefront-guided LASIK, concluding that after wavefront-guided LASIK, refractive accuracy and UCVA were similar or better compared with those achieved with conventional LASIK. The review also suggested a potential improvement in contrast sensitivity and reduced visual symptoms such as glare and halos at night versus conventional LASIK, Dr. Sun reported.[3]

Dr. Sun outlined a number of potential advantages associated with advanced wavefront-guided ablations. He explained that the current technology is proven and provides exceptional results. The technology has been available for several years, offering a range of treatments approved by the U.S. Food and Drug Administration. It treats aberrations in the entire eye, not just corneal astigmatism, and its diagnostics consider the entire optical system, with broad data capture and measuring all ocular aberrations.

Using wavefront information personalizes every procedure, Dr. Sun said.

The latest wavefront-guided technology offers an

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Mean (SD) Median (Range)	Preoperative	Postoperative	p-value
LogMAR UDVA	1.76 (0.24) 1.70 (1.40 to 2.00)	–0.03 (0.12) –0.06 (–0.18 to 0.30)	<0.001
Sphere (D)	–6.24 (1.64) –6.00 (–9.00 to –3.00)	0.00 (0.16) 0.00 (–0.25 to +0.50)	<0.001
Cylinder (D)	–1.34 (0.92) –1.13 (–3.00 to 0.00)	–0.13 (0.29) 0.00 (–1.00 to 0.00)	<0.001
Spherical equivalent (D)	–6.91 (1.70) –6.81 (–9.75 to –3.62)	–0.06 (0.20) 0.00 (–0.50 to +0.50)	<0.001
LogMAR CDVA	–0.01 (0.10) 0.00 (–0.18 to 0.30)	–0.06 (0.06) –0.08 (–0.18 to 0.00)	0.021

Figure 1. Preoperative and postoperative visual and refractive data ($p<0.05$)

improved ablation profile based on the optical aberrations in the entire eye, Dr. Sun said. The technology also features a higher-quality aberrometer, increased dynamic range, more precise torsional alignment, and corneal curvature compensation, he continued.

The iDesign Advanced WaveScan Studio System (Abbott Medical Optics, Abbott Park, Ill.) has a high-definition sensor that maximizes capture rates, Dr. Sun explained. The increased resolution offers the ability to capture more patients, greater spot quality, reduced spot crossover effect, detection of higher-order aberrations, and good reconstruction, he said. The high-definition Hartmann-Shack sensor of the iDesign, which offers five times greater resolution compared with the WaveScan, allows detection of highly aberrated eyes, such as in keratoconus, post-incisional refractive procedures, and irregular ablation profiles.[4]

Dr. Sun retrospectively evaluated clinical outcomes after LASIK to correct myopia and myopic astigmatism using the WaveScan Advanced CustomVue (100 eyes) and iDesign (26 eyes) systems. All eyes were targeted for emmetropia.

First he analyzed the clinical outcomes of LASIK based on iDesign measurements. Results are shown in Figure 1. All eyes were within 0.5 D of target. Before surgery, in 90% of eyes monocular CDVA was 20/20 or better, in 95% it was 20/25 or better, and in 100% it was 20/40 or better; postoperatively, in 80% monocular UDVA was 20/20 or better, in 95% it was 20/25 or better, and in 100% it was 20/40 or better. Contrast sensitivity was improved in dim and bright light after treatment with iDesign.

He also compared the aberrometric outcomes with WaveScan versus iDesign LASIK.

Dr. Sun explained that wavefront-guided and wavefront-optimized ablations are both highly effective, safe, and predictable in treating myopia with and without astigmatism, but wavefront-guided ablations offer more "super-vision" through better handling of higher-order aberrations and better axial and torsional alignment.

He added that advanced diagnostic technology helps improve wavefront image capture rate, especially in highly aberrated corneas.

Conclusion

New technology offers an unprecedented level of customization, and surgeons can combine treatments, Dr. Sun explained. Higher-resolution diagnostics can help surgeons provide higher quality vision. To achieve these results, surgeons need to adapt their technology and measurement standards, he said.

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