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LENS-BASED TECHNOLOGY ADVANCEMENTS:

Using Extended-depth-of-focus Lenses to Treat Cataract and Presbyopia

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CONTENT SOURCE

This continuing medical education (CME) activity captures content from a roundtable activity held in October 2017.

ACTIVITY DESCRIPTION

Ophthalmologists, optometrists, and allied health professionals have seen intraoperative aberrometry, enhanced or extended-depth-of-focus IOLs, new IOL calculators, presbyopia-correcting IOLs, and corneal inlays inundate the market over the past few years. Before integrating these technologies into practice, clinicians will need to understand them and the benefits they offer patients.

TARGET AUDIENCE

This certified CME activity is designed for anterior segment specialists and general ophthalmologists involved in the management of presbyopia and cataract.

LEARNING OBJECTIVES

Upon completion of this activity, the participant should be able to:

- Explain how to evaluate postrefractive surgery patients for presbyopia-correcting intraocular lens implantation
- Summarize the technology behind extended-depth-of-focus intraocular lenses
- Discuss lens-based options for the treatment of presbyopia

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Lens-Based Technology Advancements:
Using Extended-depth-of-focus Lenses to Treat Cataract and Presbyopia

Correcting presbyopia remains a significant, common challenge for ophthalmologists, as this condition affects approximately 14% of the world's population and is pervasive in patients older than 65.[1] Advances in presbyopia-correcting IOLs (PCIOLs) have allowed patients to enjoy spectacle independence and an increased range of vision. However, patient selection through preoperative diagnostic testing and appropriate counseling is key to a successful outcome and happy patient. The following roundtable discusses the decision-making process for PCIOL selection in cataract and noncataract patients, the importance of centration, and mixing and matching these lenses in the real world.

—Steven Dell, MD, moderator

ASSESSING PATIENT NEEDS

Q | STEVEN DELL, MD: How do you begin a discussion about PCIOLs when counseling a patient with presbyopia who also has reduced acuity because of cataract? Let us add this patient is unfamiliar with many terms and concepts that are familiar to us. For example, they may just be learning that they have a dominant and a nondominant eye. How do you convey what these lenses do?

FRANCESCO CARONES, MD: I like to start with the idea that the patient is going to get a PCIOL unless there is a medical reason for them not to. For a case like the one that you describe, my standard of care is to consider the patient a good candidate for the best technology I can provide: PCIOLs. If the patient has astigmatism, I would recommend a toric PCIOL.

Patient counseling is 90% of the success of the surgery, especially when dealing with PCIOLs. During the consultation, you must identify patients expectations and any compromises they are willing to make in order to be spectacle independent. The questions I ask are, 'How do you envision your vision after the surgery? Where do you want to be? What does spectacle independence mean to you? Can you accept light disturbances in your night vision?' The lens must be selected together with the patient.

DR. DELL: So the assumption is that if a patient is a good medical candidate, the default condition is that they will get a PCIOL.

DR. CARONES: Correct.

DR. DELL: So we are not really offering IOL upgrades, we offer IOL downgrades. This is something that many of us have adopted; top-quality IOL technology is the baseline. If there are medical or economic compromises that require us to change our plan, then we act accordingly. What about a patient who has normal ocular anatomy but is challenging from a refractive standpoint? For example, a low myope who removes glasses to read? How do we counsel them?

ELIZABETH YEU, MD: PCIOL technology is so good that, like Dr. Carones, I come in thinking that my patient will be a candidate. There have been significant improvements in patient-reported uncorrected functional vision and satisfaction with uncorrected vision in the next-generation of these lenses compared to what was available 20 years ago.[2] The data are robust. A year-long study from Marchini et al found that accommodating IOLs achieved better distance-corrected near visual acuity (VA) and lower near distance refractive addition compared with monofocal controls.[3] A large review of 20 clinical trials (2,061 people; 3,194 eyes) by de Silva et al assessed the visual effects of PCIOLs in comparison with monofocal lens implantation. Distance visual acuity was similar in the multifocal and monofocal groups, but patients with multifocal lenses had better near vision and were more likely to be spectacle independent.[4] That being said, adverse visual phenomena, such as halos and glare, were common and did bother some people.[4] Not every PCIOL is suitable for every patient, which is why patient selection is so important with this technology.

There are three types of patients who concern me from a refractive standpoint: voracious readers, high hyperopes and natural myopes, and prior corneal refractive surgery patients. Depending on the IOL design, some PCIOLs may perform better at various near or intermediate distances.[5] For patients who love reading and take their glasses off to read, I look at their reading habits. Are they using books, a computer, or an e-reader? How tall are they? How long are their arms? Someone who is very tall will have a longer arm span for reading, which may be intermediate distance for an average-height person. Someone who is very short (under 5'1) will have a shorter arm span and perhaps a tougher time reading without glasses.

Higher hyperopes concern me because we may have a refractive miss. These short eyes are unique. Some of these patients have extremely high K values, which makes them somewhat emmetropic. You know there is a potential for a myopic miss in patients +3.00 D and above, because the image may degrade below adequate levels for good visual function.[6]

Many myopic patients are used to removing their glasses to read. I strongly recommend having an in-depth conversation with these patients to determine the best option for them. Is it going to be doing a PCIOL that is more in the multifocal with a mid-add range? Or is an extended-depth-of-focus (EDOF) IOL (Figure 1) with a mild to minus offset in a nondominant eye going to be an acceptable option?

Lastly, those patients who have undergone prior refractive surgery, such as radial keratotomy (RK) or myopic LASIK, are at a higher risk of a refractive "miss." Fortunately, we owe a lot to Doug Koch and Graham Barrett for their work, which has led to the postrefractive ASCRS online calculator and the Barrett True K formula. These have increased my refractive predictability quite significantly, and are more accurate than even the historical method for IOL calculations.

ROGER ZALDIVAR, MD: Patients with natural monovision are always tricky. An EDOF IOL is a very good alterative as an upgrade to more functional vision and improved far vision without sacrificing stereopsis in these patients.

SONDRA BLACK, OD: We have found the EDOF lenses can be quite forgiving if the exact target is not met. An ideal target is erring between plano and -0.25 D. The patient then still achieves a good quality 20/20 and has all the advantages at near. If patients are slightly plus, then they can still maintain the great distance, although they will be less satisfied with the near.

For those patients who want a bit more near, targeting a mini-monovision can achieve that. We target -0.50 D in the nondominant eye. The patient may get more night vision disturbances due to the myopia and has to be counseled about that. Ideal patients for this are the prior monovision contact lens wearers, since they are already used to the night vision issues, but are happier with this approach as they are much more binocular at all distances with no "dead zones."

PATIENTS POSTREFRACTIVE SURGERY

Q | DR. DELL: Let us say a patient had good-quality wavefront-guided or wavefront-optimized LASIK within the last 10 years. The corneal topography looks relatively uniform. Where does that patient fall in your decision process?

DR. BLACK: An EDOF lens is a great option for postrefractive patients where target is a little trickier to achieve. We have also used this in a couple of post-RK eyes with decent topography and no more than 8 cuts as this can compensate for some of the refractive fluctuations these patients experience.

AMIR HAMID, MD: I presented a large case series at the ASCRS-ASOA Symposia and Congress in 2017 that compared the visual performance of four EDOF IOLs 3 months postoperatively. All four IOLs produced excellent results with high levels of spectacle independence.[7] Therefore, we routinely implant EDOF IOLs in patients who have had previous refractive surgery, as long as we follow certain guidelines.[8]

"Higher hyperopes concern me because we may have a refractive miss."

—Elizabeth Yeu, MD

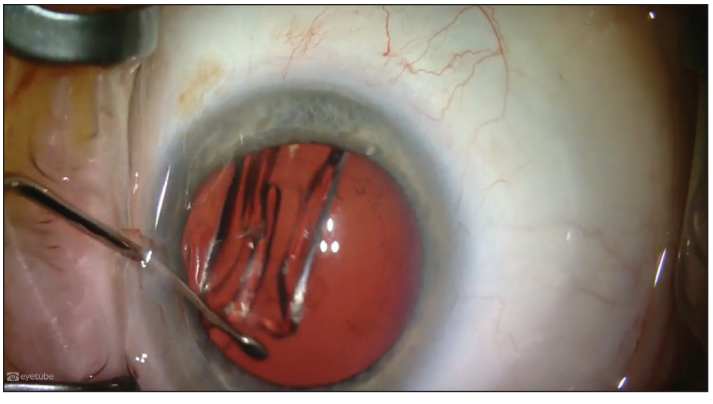
First, the topography has to be normal. There has to be a good ablation, no decentration, no irregular astigmatism, and no significant higher-order aberrations. We also do not want the patient to have significant, negative spherical aberrations because of how the Tecnis Symfony works; the lens uses diffractive optics to expand and correct chromatic aberration. It does not mean that people who have had previous hyperopic LASIK cannot have an EDOF lens, but it is something to consider.

Some patients with hyperopic LASIK can have high levels of negative spherical aberration, and this can be a contraindication to implantation of an EDOF IOL with negative spherical aberration as well as compromised visual quality.

Second, we determine if the patient had significant dry eye post-LASIK and ensure that there has not been a loss of BCVA. Third, we use corneal pachymetry to ensure the cornea is thick enough to perform an enhancement, if needed.

Understanding the patient's goals and setting realistic expectations are the most important things to determine at the start of the consultation. This is especially true in patients who have been spectacle independent for years. We have been very happy with our results. Our spectacle independence rates are very high postoperatively.

DR. DELL: Have you had negative experiences with patients who had irregular topography?



Courtesy of Jason J. Jones, MD

Figure 1. A surgeon implants an EDOF IOL.

DR. HAMID: Yes, which is why we created these criteria. After we became more confident implanting EDOF IOLs, we decided to try them in patients with forme fruste keratoconus or slightly decentered ablations. Although these patients would gain spectacle independence, the quality of their vision would sometimes be compromised.

An irregular topography does not necessarily lead to a poor patient experience if the patient has been effectively counseled preoperatively. No one should be denied this technology, but the potential complicating factors, such as previous refractive surgery, irregular astigmatism, glaucoma, or some retinal disease,[6] should be explained. For example, multiple studies have shown that patients with an astigmatism of 1.50 D or more leads to poor optical quality, compromised distance and intermediate vision, and more pronounced halos.[9] Patients who have had previous refractive surgery clearly value spectacle independence and may have unrealistic expectations. There is surprising little data looking at this patient population specifically, but the studies that do exist show that enhancement may be needed to achieve the desired results.[10-12] Patients with glaucoma experience reduced contrast sensitivity, and multifocal IOLs may further exasperate that condition.[13]

It is about understanding the risks, the benefits, and the potential implications. I will tell them that they may not see as well as someone with a perfect, healthy, virgin eye, but they will still get a significant benefit from these lenses.

This process has informed my whole practice. We have been using the Symfony for 3 years and have had good results with these types of cases. It is a forgiving lens, most ideal for postrefractive patients.

DR. DELL: Do you have any experience in post-RK eyes?

DR. YEU: Post-RK eyes are challenging because of the variation in the patients vision and decreased contrast. I have done it, and it is important to follow the same tenet that Dr. Hamid outlined. I only recommend EDOF lenses in post-RK eyes with 12 incisions or less. Eight incisions or less is ideal, because your refractive targets and outcomes are more predictable. The more incisions, the more irregularity you will have. I have no experience using a multifocal IOL in any post-RK eyes.

You can use EDOF lenses in post-RK patients if their topography has nice regularity with minimal gaping. Their astigmatism should also be fairly normal with no skewing or irregularities to the shape of the astigmatism. If the central flattening is well-centered bed, these patients do very well. Post-RK eyes naturally have more corneal pseudo accommodation, like your post-hyperopic LASIK eyes. Therefore, they actually have more range of vision, which allows them to read naturally with the same refractive error as someone who has a naive cornea.

DR. DELL: One theory is that a post-RK patient has been trained to neuroadapt to irregular astigmatism and, therefore, they are better able to tolerate aberrations than a patient with virgin eyes. Do you agree?

DR. BLACK: We have found that patients can definitely tolerate some residual astigmatism before their visual quality is compromised. We want to enhance anything over 0.75 D. If the astigmatism is against-the-rule, the lens/patient is a bit less tolerant of residual astigmatism. As this is a premium procedure, patients want the best quality vision at all distances. It is important to remember to ensure that the ocular surface is optimized preoperatively to ensure that the calculations are correct and to avoid any refractive surprises.

DR. YEU: A patient with a myopic error of -1.50 D is definitely going to experience glare and halos. Post-RK and monovision patients have already demonstrated that they can tolerate fluctuations in vision or night vision symptomatology. But if their mind can suppress that and they are happy, then this patient is someone who understands that there is a give and take to spectacle independence.

DR. DELL: Sometimes 16-incision RK eyes can have regular topographies, and sometimes four-incision RK eyes can have an irregular topography. It seems to depend on the width of the incisions. If the patient has narrow, well-healed incisions, and a 16-incision RK, they frequently have very low corneal astigmatism. They may have irregular astigmatism, but their lower order aberration for astigmatism is often quite low. We have had success using EDOF lenses in these patients, especially if they can handle the diurnal fluctuation, which is more common in 16-incision RK. What has your experience been with these patients?

DR. ZALDIVAR: I agree that we prefer using EDOF lenses in patients where the central area is respected. We all know that the cuts result in some disturbances at night, and I do not want any chance of increasing those symptoms. Therefore, we prefer RK patients with eight incisions or less because of night vision issues.

PATIENTS WITH GLAUCOMA

Q | **DR. DELL:** Where do patients with glaucoma fit into your decision tree for EDOF lenses?

DR. CARONES: Teichman et al found that patients with glaucoma can obtain excellent outcomes with proper preoperative counseling, meticulous intraoperative technique, and appropriate IOL selection.[13] My IOL recommendation depends on the amount of damage present. If there is minimal damage, no previous surgery, and a low likelihood of disease progression, then I consider that person a good candidate for an EDOF IOL. However, if there is already significant damage in the visual field with decreased contrast sensitivity, I would NEVER go with an EDOF, trifocal, or bifocal IOL. These patients are not good candidates for a traditional multifocal IOL.[14,15] You do not want to select an IOL that will reduce the amount of light energy reaching the macula.

DR. ZALDIVAR: Most glaucoma patients use glaucoma medication, which is very bad for the tear film because of tear instability. In my experience, EDOF lenses have much more tolerance to unstable

"The retinal surgeon assessment is very important because he or she will be able to tell me if the patient's visual acuity is impacted by the cataract or by the epiretinal membrane."

—Francesco Carones, MD

tear film compared to a traditional multifocal IOL, which is very important.

RETINAL DISORDERS

Q | DR. DELL: Let us move on to discuss patients with retinal disorders such as an epiretinal membrane, diabetic retinopathy, or macular degeneration. How do you break those patients out in your decision process?

DR. HAMID: I would not offer a patient with pre-existing diabetic retinopathy a PCIOL. I think that it is standard practice across the board. It is possible to offer a patient with an epiretinal membrane an EDOF IOL if it is early on in the disease process and there is no evidence of distorted VA. You may want to get a retinal opinion before proceeding to establish if the epiretinal membrane will progress. I have had some very good results with these patients.

For a patient with early macular degeneration and some drusen, I do not see any reason they cannot have an EDOF IOL. Yes, you are worried about some loss of contrast in macular disease, but we do know that the contrast is maintained quite significantly with the EDOF IOL. However, the patient could have a healthy macula now and then could develop advanced macular degeneration after you put a premium lens in. It is a possibility you have to discuss with them. Early macular degeneration should not exclude them from having an EDOF or a multifocal IOL. I have a much lower tolerance for offering an EDOF IOL in cases of macular degeneration, because I think the patient will still benefit from it.

DR. CARONES: We have had a good experience of using combined surgery, epiretinal membrane peeling, and simultaneous implant of an EDOF IOL in patients with an epiretinal membrane. All cases go through a retinal surgeon examination to detect how important is the traction of the membrane. The choice whether or not to implant an EDOF IOL also comes from the perspective of VA, especially if this is a patient with an early cataract. If the VA is not significantly reduced and if there is not a lot of distortion, we will implant an EDOF IOL if the retinal surgeon can guarantee the epiretinal membrane has been successfully removed without issue. If the surgeon cannot do that or if there is significant VA loss, we will implant a multifocal IOL.

DR. DELL: All of this is done in one setting?

DR. CARONES: Yes. We remove the cataract, peel the epiretinal membrane, and implant the EDOF IOL, assuming the retinal surgeon says everything went smoothly.

DR. DELL: That is fascinating.

DR. CARONES: The retinal surgeon assessment is very important because he or she will be able to tell me if the patient's VA is impacted by the cataract or by the epiretinal membrane. If, for example, a patient has 20/25 BCVA and traction, we will move the traction at time of surgery and then perform the surgery as described.

DR. DELL: What do you do to manage the risk of the patient getting cystoid macular edema (CME)?

DR. CARONES: If the CME is related to the retinal surgery we prescribe oral steroids. They are extremely effective in controlling it. We do not use intravitreal steroids if CME is not present, but if it does develop, we will use it. I do not believe nonsteroidals are as effective as steroids. I am quite aggressive in controlling CME and think patients respond much better to oral therapy. If you have CME and you give a patient 25 mg of oral prednisone, the CME disappears in less than 24 hours.

DR. YEU: I am a little bit more conservative from a pathology standpoint. If I see anything that could be a perifoveal, foveal, or epiretinal membrane, I do not consider any advanced IOL that could reduce contrast sensitivity. I would consider a toric monofocal IOL, but would not consider an EDOF IOL. I do not want to see subfoveal drusen, as it can be visually limiting and the chance of progression is much higher in those patients. By limiting them to a toric monofocal IOL, you are providing them with the best care now and protecting them for the lifelong haul.

On the other hand, I have had excellent results using an EDOF IOL in older patients with mild, 1+ corneal guttata, where progression is unlikely. We have excellent pachymetry technology. If you are clearly less than 600 µm and the patient is not complaining about the glare associated with their guttata, then they will do well with an EDOF IOL.

DR. DELL: That is surprising. I have been shy about implanting an EDOF IOL in patients with guttata because of concerns about light scatter. But you have had good success doing that?

DR. YEU: Yes, we have had wonderful success with this. However, the outcome will be very different in a 50-year-old patient with 2+ guttata. I fear increasing his or her positive dysphotopsias particularly, and I do not want the patient to be unsatisfied.

MANAGING OCULAR SURFACE DISEASE PREOPERATIVELY

Q | DR. DELL: When a patient comes in for a cataract workup in your clinic, what is the standard battery of testing that occurs?

DR. ZALDIVAR: We do an optical coherence tomography, a meibography, and a tear osmolarity test in all patients. Moreover, we like to understand the optical quality of the eye so we perform the dynamic double-pass aberrometer HD analyzer on every patient. We developed a software-based artificial intelligence to classify the different tear film patterns arising from the study. Our experience has demonstrated that EDOF IOLs are much more forgiving platforms than multifocal IOLs in patients with unstable tear film patterns.

DR. CARONES: You want to make sure that when you see the patient, you already know if there are any reasons not to upgrade the patient to a multifocal IOL.

DR. DELL: What do you recommend for a patient with ocular surface disease such as dry eye (Figure 2), blepharitis, or meibomian gland dysfunction (MGD)? Are these nonstarters for premium IOLs or do you put them through rehabilitation and reassess?

DR. HAMID: We rehabilitate those eyes. We treat the causes of the ocular surface disease and reassess. Oftentimes, patients respond very well to treatment using a step-wise approach, and then we can perform the surgery. The stepwise approach starts with ocular lubricants, followed by topical steroids, punctal plugs, and then, of course, a doxycycline. If more interventions are needed, then that patient may not be the best candidate.

DR. ZALDIVAR: Then, of course, you have all the options that come with treating MGD such as lid peeling, lid expression, lid debridement, and BlephEx debridement.[16] All of these things really help improve the situation.

DR. CARONES: The other reason you want to rehabilitate the patient is because your calculations will be much more accurate. Calculations are needed for monofocal and premium IOLs. I want to make sure I have the most accurate measurement possible to process the final power of the IOL.

DR. DELL: So, those principles really apply to all of your IOL patients.

DR. CARONES: Yes, they do.

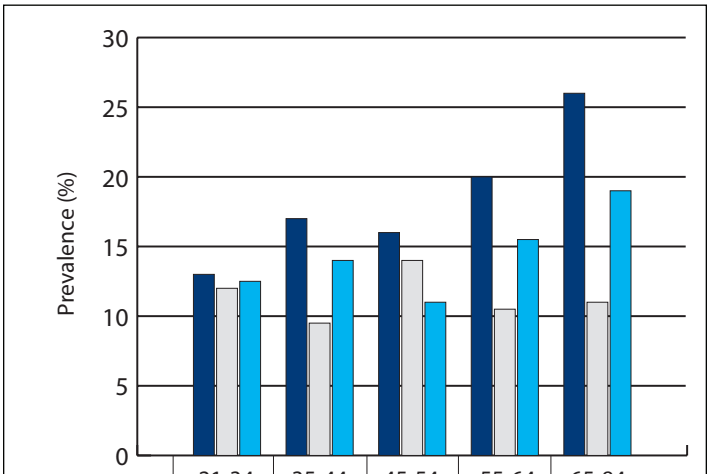
DR. DELL: Moving on to diagnostics, what are your thoughts about meibomography? Where does that fit into the equation?

DR. YEU: More and more surgeons are recognizing that ocular surface goes hand in hand with cataract surgery. That is the good news. If you look at the 2016 ASCRS Clinical Survey, 96% of surgeons agree that you have to optimize the ocular surface or you could compromise outcomes.[17]

Part of my process includes getting a LipiScan or infrared meibography on every patient to have a snapshot of his or her meibomian gland architecture. That alone gives you so much information as to the potential chronicity of the disease state. Many patients do not necessarily complain about symptoms, except for their fluctuating vision. If you miss that, you do not know that there is MGD that has caused truncation and dropout of the glands. We are missing this in a huge amount of patients.

I also think these diagnostics, combined with topography and the consistency among the different measurements, help guide the conversation with the patient. That conversation can be easier when you have something to show them; when they can directly see what their lids look like compared with a healthy eye. Then you can explain that some people experience redness and burning, while others only notice vision fluctuations during the day or with prolonged activities such as reading. From there, you create a contract with the patient. You will get them prepared for surgery but for them to maintain the vision afterward, the dry eye and MGD has to be under control.

I start with Omega fatty acid supplements, and my go-to supplement is HydroEye. I have found that many people are resistant to instituting prescription drops if they have never used them before. This is why oral nutraceuticals and LipiFlow are so vastly important. Numerous studies demonstrate that one LipiFlow procedure alone is going to be more effective than daily dry eye treatments for at least the duration of a year.[18-22] That resonates with patients. We also offer a discounted rate for patients doing it perioperatively around the



	21-34	35-44	45-54	55-64	65-84
Women	13.2	17.4	16.5	19.9	25.6
Men	12.3	9.7	10.9	10.2	11.2
Overall	12.8	14	13.9	15.5	18.9

Paulsen AJ, Cruickshanks KJ, Fischer ME, et al. Dry eye in the Beaver Dam Offspring Study: prevalence, risk factors, and a health-related quality of life. *Am J Ophthalmol*. 2014;157(4):799-806.

Figure 2. Prevalence of dry eye symptoms in a population-based study.

time of surgery, which encourages patients to follow through and promotes compliance.

DR. DELL: We published a study on intense pulsed light (IPL) for MGD, and there is no question that IPL is efficacious.[23] In our study, all examined outcome measures, including tear break-up time, meibomian gland score, corneal fluorescein staining, Standard Patient Evaluation of Eye Dryness questionnaire, and tear film osmolarity, significantly improved after 15 weeks of IPL treatments. LipiFlow is really helpful as well; the two are truly synergistic.

DR. ZALDIVAR: I think it is a package treatment today: meibomian probing if the glands are totally blocked, meibomian expression, LipiFlow, and IPL. The combination works.

DR. DELL: What are your strategies for explaining to a patient with significant dry eye that the dry eye has to be dealt with before proceeding?

DR. ZALDIVAR: We have a very nice example of this. If you have the fastest car in the world with the best driver in the world, but the windshield is dirty—causing the car not to perform at the speed it is designed to—then the windshield has to be clean so you can appropriately use the technology that you have.

DR. YEU: Oftentimes, patients want their cataracts out the same day as their evaluation. When you tell them that they have to come back at a later date, they are disappointed and lose faith in the process. Depending on what I am seeing, I will give them a date for surgery, but it may be pushed out 5 to 7 weeks after the evaluation because I want them to have the best possible outcome. This accomplishes two things: it gives me time to improve their dry eye, and it gives them a date to look forward to and plan around.

OPTIMIZING PATIENT-PHYSICIAN COMMUNICATION

Q | DR. DELL: The internet has allowed patients to do a fair bit of research on IOLs before they come in for a consultation. They may come in with quite specific questions regarding the optical performance of these lenses. How do you explain satisfaction rates and optical performance of premium lenses (Figure 3)?

DR. ZALDIVAR: Satisfaction rates are very high, even coupled with LASIK.[24-28] If you show someone that there is 93% to 95% satisfaction rate with these lenses, then that helps a lot.

DR. DELL: Do you explain the potential for reduced contrast sensitivity, and, if so, how do you approach that conversation?

DR. YEU: I do explain contrast sensitivity to patients. I also explain that the technology is at a level where we are fortunate to have the kind of optical quality we use. The lenses that give patients distance and range of vision use the same type of optics

Figure 3. How do you explain satisfaction rates and optical performance of premium lenses to patients?

that are found in the most powerful telescopes. That is highly impressive for patients to hear.

DR. ZALDIVAR: Whether or not I mention contrast sensitivity depends on who my patient is and the current state of his or her contrast sensitivity. For example, if they already have compromised contrast, I probably will not bring it up. I spend a lot of time speaking about how incredible the technology is and how happy we are with what we have today. But it is not like being born again; patients may see slightly different light patterns at night, which may improve with time.

DR. CARONES: I tell my patients that there is a slight compromise that comes with the technology, but that the technology is great. If their goal is to be spectacle independent, I explain that the tradeoff is slightly reduced contrast sensitivity. Most patients will not even notice the reduction in contrast, and if they do, it will only be at night.

DR. HAMID: We tend to be a little more upfront in Europe. Ninety-five percent of my patients are clear lens extraction, and they are incredibly sensitive to their outcomes. I tell them that our results are very good, and our ability to deliver good results is consistent. But I am direct and honest with how I present the limitations, and I think patients appreciate that. I tell them they may experience reduced contrast sensitivity symptoms, but that they will fade with time.

DR. DELL: I think patients are highly influenced by the demeanor and communication style of the surgeon. If the surgeon begins the consultation by apologizing for the limitations of the technology, the patient's success perception of that technology goes way down. You still have to disclose the compromises that come with the technology. Patients understand they cannot have everything, and that compromises are required. But the demeanor with which this information is presented can be very influential on the patient's perception of success or failure.

"You still have to disclose the compromises that come with the technology. Patients understand they cannot have everything, and that compromises are required."

—Steven Dell, MD

It is also important to provide the patient with a firm IOL recommendation. If you provide them with too many options and leave the decision up to them with little direction, they get confused. You have to give them a definitive recommendation that meets the goals that they have outlined to you through their discussion and otherwise.

DR. CARONES: That is an extremely good point. In Europe we have a wider availability of IOLs than the United States. We never leave the patient with a choice between IOLs; we always recommend something based on their needs and goals.

DR. ZALDIVAR: That is why we are specialists. We have studied this and can make a more informed decision of what is best. But you have to take the time to really understand the patient and their needs and goals.

DR. DELL: I was asked by a colleague to visit his clinic because he was having difficulty with premium IOL conversions. I went in an examination room with him and watched him counsel a patient. At the end of the consultation, he gave the patient three or four IOL brochures and told them to go home and figure out what they wanted. That does not work. You have to identify the visual desires of the patient, and then make a firm recommendation that meets those desires as best you can.

KEYS TO IOL CENTRATION

Q | DR. DELL: Proper IOL centration has long been known as an important factor in maximizing VA in patients. Centration is especially important for premium IOLs, as decentration can hinder BCVA.[29] What are your tips for centration? What landmark should these lenses be centered on, and how do you go about achieving that?

DR. CARONES: Centration is acutely important for traditional diffractive IOLs, especially in patients with astigmatism. It is very important to evaluate the angle kappa before surgery, as multiple studies have shown.[30,31] The higher the angle kappa, the more difficult centration will be.[30] However, if the angle kappa is not wide, then centration is not an issue. If you have an associated astigmatism to correct, sometimes you cannot center the lens because you are askew on the astigmatism axis. My two take-home messages are to avoid diffractive IOLs in patients with wide-angle kappas. Secondly, EDOF lenses make centration much easier. In most cases I would exclude a diffractive multifocal IOL in a high-angle kappa patient, but I would consider an EDOF lens.

DR. YEU: Angle kappa is the lowest priority on my list when I think of things that concern me about centering. I am looking for higher-order aberrations, ocular surface disease, and pathology. All multifocal and EDOF IOLs should be centered as closely as possible on the entrance pupil, and EDOF IOLs do have a more larger central optic to work with. IOLs, in general, will have a tendency to center themselves within the capsular bag. But if you off-center it, and you take a little bit of extra time to make sure that it is tapped down and touching the posterior capsule, it can be a little off-centered nasally the way you want it to be. Due to the larger central button of the EDOF lens, there is more forgiveness there, and patients will be clinically much less affected by a difference between the central optic and the visual axis. Even if it is not quite centered, their central vision is still excellent. It is rare to have any eccentric aberration that they may complain about, and their central vision is always well preserved.

DR. DELL: I had the opportunity to review a large dataset of more than 300 patients with a diffractive multifocal.[32] We looked at angle kappa preoperatively versus patient satisfaction postoperatively. We were surprised to find that angle kappa really made no difference. I used to be very concerned about angle kappa, but now I do not pay much attention to it.

DR. CARONES: I think the value of angle kappa also makes a difference. A wide-angle kappa would be 600 µm or more. Anything less than 600 µm is not an issue.

DR. DELL: What are you centration pearls?

DR. YEU: Multiple studies have examined surgical approaches for maximum centration success. At the most practical level, it starts by using a femtosecond laser to create the capsulorrhexis, which is backed up in the literature.[33-35] For example, a study by Kranitz et al assessed decentration and tilt following a circular capsulotomy created with a femtosecond laser to a manually performed continuous curvilinear capsulorrhexis. Unsurprisingly, a capsulorrhexis created with a femtosecond laser resulted in a more stable refractive result and less IOL tilt and decentration than one created manually.[33]

PEARLS FOR MIXING AND MATCHING IOLS

Q | DR. DELL: In what situations do you mix and match lenses?

DR. BLACK: For the patient that spends the majority of the day on a computer or for those patients (especially men) that read at

50 cm, we prefer to do bilateral Symfony. We do a lot of mix and match for patients who do more near work at a closer distance. We place the Symfony in the dominant eye and then determine which lens should go in the other. I generally will ask the patients to show me where they prefer to read, and based on that will decide which lens should go in the nondominant eye. If the patient reads at 40 cm, then we will use a Tecnis Low Add with +3.25, but we have even used the +4.00 for those that prefer a 33 cm working distance. We have found this approach works really well as it gives patients great flexibility and yet maintains great quality of vision in all lighting conditions.

DR. YEU: I take the patient's height and reading needs into consideration. My goal is to implant a Symfony in both eyes, but I may change that if the patient is extremely short or extremely tall. I start with the nondominant eye with just a little myopic offset, somewhere between -0.25 D and -0.50 D because that reduces night vision symptoms. I would say about 1.5% of my patients have significant complaints about night vision. By operating on the nondominant eye first, it provides the patient with social reading but helps reduce night vision symptoms. This approach has been very successful and has worked for me.

For those patients who really enjoy reading and have a low astigmatism, I will start with their dominant eye going for plano and then see how happy they are with their near vision. Then, I will decide if I am going to offset with a Symfony or a Tecnis multifocal. The spacing between the eyes is 1 or 2 weeks.

DR. ZALDIVAR: I have used Symfony in the nondominant eye with a bifocal and Symfony in the nondominate eye with a trifocal in the past. It works. What I do not like of mixing optics is the comparison between eye to eye. I prefer having both eyes targeting.

DR. DELL: How do you approach a patient who had cataract surgery 5 years ago and he or she has a plano monofocal implant in one eye? What do you recommend for the fellow eye?

DR. CARONES: We assume that the patient is asking for some kind of spectacle independence. It is all a matter of conversation, whether to implant a trifocal or an EDOF IOL. I have implanted trifocal and EDOF lenses and the results have been good in both cases. The amount of spectacle independence we are going to provide these patients with is not as high but, for many of them, it is better than a monofocal.

DR. HAMID: I prefer to offer the patient an EDOF lens in the fellow eye. There is very little difference in contrast between the monofocal and the EDOF lens. There is also very little difference in dysphotopsia symptoms. Patients tend to notice the comparison much less if you provide them that greater degree of spectacle independence. It is not as good as bilateral implantation, but certainly much better.

DR. ZALDIVAR: I have not had good experiences doing monocular trifocal or even bifocal. I would rather implant an EDOF lens in the nondominant eye.

DR. YEU: I implant an EDOF lens in the fellow eye because the quality of the technology is excellent. My patients who have an older generation monofocal in the other eye will say how much better their distance vision is in the EDOF eye. It is crisper than the monofocal, which really speaks to the overall optic quality of the EDOF lens.

PEARLS FOR LENS EXCHANGES AND CORNEAL INLAYS

Q | DR. DELL: Let us talk about the 50-year-old plano presbyope. This patient does not use glasses for distance and has clear lenses, but he or she uses reading glasses and hate it. How do you approach this patient?

DR. HAMID: I would perform a refractive lens exchange in these patients.

DR. CARONES: It is difficult to generalize the answer because every case will be different. If the question is what can I do to give this patient spectacle independence, to me the only answer is refractive lens exchange. All other solutions, at least in my hands, are not as satisfactory as refractive lens exchange. My lens selection depends on the patient's expectations. I would start with one eye, but the likelihood is that the patient will ask for the second eye to be done as well.

DR. YEU: This is where my HD analyzer and diagnostics help guide me. Like Dr. Carones said, no case is the same. If diagnostics show that the patient is having some contrast issues, then I will recommend a lens exchange. I may consider a corneal inlay if they have great contrast and I want to preserve their dominant eye for potential future technology.

DR. CARONES: Corneal inlays are not always reversible. Then you have a footprint that makes the case much more challenging if you need to do a refractive lens exchange later.

DR. ZALDIVAR: We did a study on this in our clinic, although we never did publish it. About 50% of these patients tolerate micro monovision very acceptably, about 1.00 D. Those patients are good candidates for presbyLASIK or a clear lens exchange within the nondominant eye with an EDOF IOL. That is our approach.

DR. DELL: I think the message is that our PCIOLs have progressed to the point where we would consider tackling that type of patient. We never would have with older generation multifocals.

DR. CARONES: If our goal is to provide the patient with the most efficient technology today, there is no question that a PCIOL

is better than a laser, monovision, micro monovision, and presbyLASIK. The only issue related to that is the fact that it is not a conservative surgery.

DR. YEU: The technology is not the limitation, it is the potential ramifications and complications of the surgery. You have now taken away any natural accommodation. There is also the risk of retinal detachment. These are the things that keep me from wanting to do a refractive lens exchange, not the technology.

DR. DELL: It is clear that PCIOLs have improved dramatically in the last several years, and we are now consistently delivering excellent uncorrected distance, intermediate, and near vision in a very high percentage of patients. As the technology has improved, we have gained confidence in offering these lenses to patients in whom we would have been reluctant to use older IOLs. Because the optical concepts involved can be complex, it is important to quickly determine the patient's visual goals and clearly communicate their options. Attention to the ocular surface as well as coexisting ocular pathology factors into this equation as well. By adhering to the principals outlined today by our superb panel of surgeons, excellent results can be obtained. ■

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LENS-BASED TECHNOLOGY ADVANCEMENTS:
Using Extended-depth-of-focus Lenses to Treat Cataract and Presbyopia

Release Date: January 2018
Expiration Date: January 2019

INSTRUCTIONS FOR CME CREDIT

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DEMOGRAPHIC INFORMATION

Profession
___ MD/DO
___ NP
___ Nurse/APN
___ PA
___ Other

Years in Practice
___ >20
___ 11-20
___ 6-10
___ 1-5
___ <1

Patients Seen Per Week (with the disease targeted in this activity)
___ 0
___ 1-5
___ 6-10
___ 11-15
___ 15-20
___ 20+

Region
___ Northeast
___ Northwest
___ Mid-West
___ Southeast
___ Southwest

Setting
___ Solo Practice
___ Community Hospital
___ Government or VA
___ Group Practice
___ Other
___ I do not actively practice

Models of Care
___ Fee for Service
___ ACO
___ Patient-Centered Medical Home
___ Capitation
___ Bundled Payments
___ Other

Training of Fellows ___ Yes ___ No

LEARNING OBJECTIVES

DID THE PROGRAM MEET THE FOLLOWING EDUCATIONAL OBJECTIVES?	AGREE	NEUTRAL	DISAGREE
Explain how to evaluate postrefractive surgery patients for presbyopia-correcting IOL implantation	_____	_____	_____
Summarize the technology behind extended-depth-of-focus IOLs	_____	_____	_____
Discuss lens-based options for treatment of presbyopia	_____	_____	_____

POST TEST QUESTIONS

1. **PLEASE RATE YOUR CONFIDENCE ON YOUR ABILITY TO MAKE A PCIOL RECOMMENDATION BASED ON A PATIENT'S NEEDS AND GOALS. (BASED ON A SCALE OF 1 TO 5 WITH 1 BEING NOT AT ALL CONFIDENT AND 5 BEING EXTREMELY CONFIDENT).**
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

2. **PLEASE RATE HOW OFTEN YOU INTEND TO APPLY ADVANCES IN CORRECTING PRESBYOPIA TO "REAL-WORLD" PATIENT ASSESSMENT, DIAGNOSIS, TREATMENT, AND MANAGEMENT. (BASED ON A SCALE OF 1 TO 5 WITH 1 BEING NEVER AND 5 BEING ALWAYS).**
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

3. **WHAT IS THE MOST IMPORTANT FACTOR FOR A SUCCESSFUL REFRACTIVE CATARACT SURGERY?**
   a. Surgical technique
   b. Appropriate diagnostics
   c. Preoperative patient counseling
   d. Centration

4. **A REFRACTIVE MISS IS A PRIMARY CONCERN IN WHAT TYPE OF PATIENT?**
   a. High hyperopes
   b. Heavy readers
   c. Natural myopes
   d. Computer users

5. **WHICH TYPE OF LENS IS BEST USED FOR POSTREFRACTIVE PATIENTS BECAUSE OF ITS FORGIVING NATURE?**
   a. Monofocal
   b. EDOF
   c. Multifocal
   d. Accommodating

6. **A MULTIFOCAL IOL IS ONLY RECOMMEND IN POST-RK EYES WITH _____ INCISIONS OR LESS.**
   a. 18
   b. 16
   c. 12
   d. 8

7. **A PATIENT WITH GLAUCOMA AND SIGNIFICANT DAMAGE IN THE VISUAL FIELD WITH DECREASED CONTRAST SENSITIVITY SHOULD RECEIVE A _____ IOL.**
   a. EDOF
   b. Trifocal
   c. Multifocal
   d. Bifocal
   e. Both b and d

8. **WHAT IS THE MOST COMMON OPTICAL COMPROMISE PATIENTS RECEIVING AN EDOF LENS MUST MAKE?**
   a. Continued spectacle dependence
   b. Dry eye
   c. Night vision disturbances
   d. Reduced contrast sensitivity

9. **A PATIENT WITH A WIDE-ANGLE KAPPA OF _____ OR MORE MAY HAVE PROBLEMS WITH IOL CENTRATION.**
   a. 300 µm
   b. 400 µm
   c. 500 µm
   d. 600 µm

10. **WHICH TREATMENT FOR MGD HAS BEEN SHOWN TO BE MORE EFFECTIVE THAN DAILY DRY EYE TREATMENTS FOR AT LEAST THE DURATION OF A YEAR?**
    a. LipiFlow
    b. Intense pulsed light
    c. Lid peeling
    d. Lid expression

ACTIVITY EVALUATION/SATISFACTION MEASURES

Your responses to the questions below will help us evaluate this CME activity. They will provide us with evidence that improvements were made in patient care as a result of this activity as required by the Accreditation Council for Continuing Medical Education (ACCME).

Rate your knowledge/skill level prior to participating in this course: 5 = High, 1 = Low _____

Rate your knowledge/skill level after participating in this course: 5 = High, 1 = Low _____

This activity improved my competence in managing patients with this disease/condition/symptom ____ Yes ____ No

I plan to make changes to my practice based on this activity? _____ Yes _____ No

Please identify any barriers to change (check all that apply):

____ Cost
____ Lack of consensus or professional guidelines
____ Lack of administrative support
____ Lack of experience
____ Lack of time to assess/counsel patients
____ Lack of opportunity (patients)
____ Reimbursement/insurance issues
____ Lack of resources (equipment)
____ Patient compliance issues
____ No barriers
____ Other. Please specify: _____
_____
_____
_____

The design of the program was effective for the content conveyed. ___ Yes ___ No

The content supported the identified learning objectives. ___ Yes ___ No

The content was free of commercial bias. ___ Yes ___ No

The content was relative to your practice. ___ Yes ___ No

The faculty was effective. ___ Yes ___ No

You were satisfied overall with the activity. ___ Yes ___ No

Would you recommend this program to your colleagues? ___ Yes ___ No

Please check the Core Competencies (as defined by the Accreditation Council for Graduate Medical Education) that were enhanced through your participation in this activity:

____ Patient Care
____ Practice-Based Learning and Improvement
____ Professionalism
____ Medical Knowledge
____ Interpersonal and Communication Skills
____ System-Based Practice

Additional comments:

_____

____ I certify that I have participated in this entire activity.

This information will help evaluate this CME activity. May we contact you by email in 3 months to see if you have made this change? If so, please provide your email address below.

_____


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