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Research study targets potential treatment options for nAMD

Variations tied to functions, anatomic outcomes in anti-VEGF-treated eyes

By Cheryl Guttman Krader; Reviewed by Dr Chirag D. Jhaveri

Analyses of data collected in phase III clinical trials investigating brolucizumab (Novartis) for the treatment of neovascular age-related macular degeneration (nAMD) provide further evidence that better disease control measured by less fluctuation of OCT-measured fluid is associated with better vision outcomes. The research also demonstrated an association between stability of central subfield thickness (CST) and having a dry retina, reported Dr Chirag D. Jhaveri, at the 37th annual scientific meeting of the American Society of Retina Specialists.

“Our CATT and IVAN trials found that fluctuation of CST in eyes with nAMD treated with anti-VEGF therapy was another factor predicting vision outcome. The results of our post-hoc analysis of data from the brolucizumab trials parallel the findings from CATT and IVAN,” said Dr Jhaveri, Retina Consultants of Austin, TX, and clinical assistant professor of ophthalmology, Dell Medical School, The University of Texas at Austin.

Methodology

The analyses of CST fluctuation associations used data from 96 weeks of follow-up in the HAWK and HARRIER pivotal trials and included only patients who had more than three CST observations. HAWK randomised patients 1:1:1 to brolucizumab 3 mg, brolucizumab 6 mg, or aflibercept 2 mg, and HARRIER compared brolucizumab 6 mg against aflibercept.

All treatments were initiated with a loading phase in which patients received three doses at monthly intervals. Thereafter, brolucizumab was administered every 12 weeks with an option to adjust to dosing every 8 weeks based on predefined disease activity assessments. After the loading phase, aflibercept was administered on a fixed schedule every 8 weeks.

Retinal thickness fluctuation for each patient was quantified by calculating the standard deviation of the individual’s standardised CST. Patients were pooled from both studies and divided into quartiles based on CST fluctuation. Each quartiles included 444 patients, and they were defined by the following values: <27 μm, 27–44 μm, 44–68 μm, and ≥68 μm.

“This treatment agnostic analytic approach that does not separate patients according to treatment group can be done because the anti-VEGF agents all deliver a significant level of efficacy. Hence, the data can be combined to understand a class therapeutic effect,” Dr Jhaveri said.

The data showed that the mean gain at the end of the study decreased progressively across the four quartiles moving from the group with the lowest CST fluctuation to the group with the highest variability (+10.3, +8.8, +6.9, and +2.1 letters, respectively).

“The mean vision gain from baseline among the results of our post-hoc analysis of data from the brolucizumab trials parallel the findings from CATT and IVAN.’”

– Dr Chirag D. Jhaveri

IN SHORT

» The phase III clinical trials offer evidence that better disease control measured by less fluctuation of OCT-measured fluid is associated with better vision outcomes.
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patients in the quartile with the greatest amount of fluctuation was eight letters less than in the reference group in the lowest quartile,” said Dr Jhaveri. “This parallels the finding from the CATT and IVAN analysis.”

Reiterating that the analysis considers fluctuation in fluid (CST variability) and not its absence versus presence, Dr Jhaveri said that a separate analysis was done to investigate whether there was a correlation between fluid presence after the loading phase and CST variability.

To evaluate that question, CST standard deviation from week 12 to week 96 was calculated for each patient and used to divide the population into new quartiles. Then, the fraction of post-loading visits in which a patient had either intraretinal or subretinal fluid was calculated.

The analyses were done separately for HAWK and HARRIER patients.

The results showed that, in both studies, eyes in the quartile with the least CST variability had the least amount of visits with fluid, whereas those with the most fluctuations in CST had the most amount of visits with fluid.

“The findings indicate that a more stable retina with less CST variability is associated with a drier retina in addition to better BCVA gains,” said Dr Jhaveri.

DR CHIRAG D. JHAVERI, MD  
E: cjhaveri@e-retina.net  
Dr Jhaveri is on the advisory board for Allergan and is a consultant for Genentech and Novartis.

in case you missed it

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ASRS Preference and Trends Study shows physicians are in agreement over treatment practices.

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Clinical trials, studies highlight strategies using intravitreal anti-VEGF therapy.

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IOL with trifocal design is offering patients improved visual outcomes.

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Physician offers pearls for upper eyelid blepharoplasty surgery.
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Survey: Physicians are mostly in agreement over treatment practices

ASRS Preferences and Trends project gets responses from 41 retina societies

By Michelle Dalton, ELS

In its 20th year, the ASRS Preferences and Trends (PAT) survey is designed to track treatment trends of retinal specialists around the world. This year in addition to the ASRS, 41 retina societies around the world also participated in the Global Trends in Retina Survey. Respondents to the PAT survey included members in the United States, Canada, Mexico/Central America/South America; Africa/Middle East; Europe; Japan/Asia-Pacific; and “other.” More than 87% of all respondents were medical/surgical retina specialists, with the remaining identifying as either a medical or surgical specialist. In both groups, the majority have been in practice (after fellowship) for 8 to 15 years.

Interestingly, 69% of non-US respondents and 76.4% of US respondents have not used intraoperative optical coherence tomography (OCT), and 68.9% of U.S. respondents and 51.7% of non-US respondents have not used 3-D heads-up visualization systems in the OR.

Macular disease

Members were generally in agreement in this area, noting that if cost were not an issue, 77% of US respondents and 74% of non-US respondents would initiate intravitreal aflibercept in a patient with new-onset wet age-related macular degeneration (AMD).

In that same treatment-naïve patient, both groups would start with at least 3 monthly injections before considering treat-and-extend (TAE). However, almost 4 times as many non-US respondents (21.8%) would give the three dose-loading injections before initiating PRN as compared to their US counterparts (5.7%), whereas 22.7% of US respondents would move to TAE as soon as the retina is dry or stable compared to only 10.7% of non-US respondents.

More non-US respondents (62.2%) believe patients are being undertreated than US respondents (53.7%).

- Global Trends in Retina Survey

15% of US respondents and 25.3% of non-US respondents would initially target all wet AMD patients. Slightly more than one-quarter of US respondents would initially target wet AMD patients who have recalcitrant choroidal neovascularization despite maximal frequency dosing. Should these patients receive the implant, most respondents would recommend exams every two to three months.

Respondents were generally unaware of the phase II data on faricimab, will use brolucizumab (presuming approval and insurance coverage) on incomplete responders to other anti-VEGFs or try it on a few and expand use if they see a benefit. Almost

More non-US respondents (62.2%) believe patients are being undertreated than US respondents (53.7%).

IN SHORT

If costs were not an issue, three-fourths of respondents to the Global Trends in Retina Survey would initiate intravitreal aflibercept in a patient with new onset wet AMD.
half the respondents remain unsure complement inhibition is important to the progression/development of AMD. In this group of specialists, social media plays a minimal—if any—role in the practice. About one-quarter of the respondents overall are involved in clinical trials.

**Vascular disease**
When it comes to patients with retinal vascular disease or diabetic macular edema (DME), the responses were more varied in terms of treatment. In a 30-year-old, type 1 diabetic patient with high-risk proliferative diabetic retinopathy (PDR), but good vision (20/20) and no DME, anti-VEGF and complete panretinal photocoagulation (PRP) in sessions was as likely a treatment preference as complete PRP treatment in sessions. PRP became the leading treatment choice in that same patient who now had only mild PDR.

A smaller percentage (<20%) of respondents in both groups use anti-VEGF therapy in cases of non-PDR without DME.

Although almost 90% of respondents are aware of PANORAMA, it will have little effect on how clinicians manage non-PDR without DME.

Initial treatment of phakic patients with DME is overwhelmingly bevacizumab in the US (65%), but aflibercept outside the US (41%). Intravitreal steroids are still reserved for suboptimal responders. Treating fovea-involving clinically significant DME before a patient undergoes cataract surgery is overwhelmingly the preferred treatment strategy.

The results of the SCORE2 study have not altered management strategy among clinicians in the treatment of retinal vein occlusion (RVO). In asymptomatic patients without macular edema, observation is a common treatment strategy in central RVO.

**Pharmacology**
Clinicians will switch anti-VEGFs if vision does not improve or worsens, or if there is insufficient fluid retention. In the US, clinicians are likely to switch to a different anti-VEGF, but more non-US respondents (33%) would consider switching to a steroid than their US counterparts (8.2%).

Prefilled syringes have not made much of a difference in which anti-VEGF clinicians prefer to use.

Half the US respondents have found more insurers are mandating step therapy, or increased requirements for prior authorization.

Although voretigene neparvovec received approval in 2018, 21% of non-US respondents are unaware of the gene therapy (approved for inherited retinal dystrophies). More importantly, however, is that for the most part, clinicians do not have patients who could benefit from the treatment.
Benchmarking treatment and practice patterns among peers is one thing, but the ASRS International Affairs Committee tracks trends around the world. This year, 41 societies accepted the invitation to participate (and 1,010 members of these societies responded; 670 U.S.-based ASRS members answered the same 15 clinical questions as part of the 2019 PAT Survey. International societies were classified by region: Africa/Middle East (n=147), Asia/Pacific (n=264), Central and South America (n=211), and Europe (n=274).

ASRS International Affairs Committee Chair Rishi P. Singh, MD, Cleveland Clinic Cole Eye Institute, presented some of the highlights of the 6th annual Global Trends in Retina Survey.

Of note, not all respondents answered all questions; in some cases the total responses did not equal 100%. Here are some of the highlights:

**Global trends show similar patterns worldwide**

**Treatment patterns for wet AMD**

Treatment-naïve neovascular AMD are predominantly treated with at least three loading doses; in the majority of regions, once the loading doses are complete treatment moves to treat-and-extend. The notable exception to this is in the Africa/Middle East region, where clinicians prefer to move to PRN dosing. In the U.S., clinicians prefer to move immediately to treat-and-extend as soon as a dry or stable retina allows rather than move patients to a PRN dosing schedule.

When clinicians were specifically asked how to manage a 30-year-old, type 1 diabetic with high-risk proliferative diabetic retinopathy (PDR), but who also has excellent vision (20/20) and no DME, respondents in Africa/Middle East, Asia/Pacific, and Europe prefer complete panretinal photocoagulation (PRP) in 2 or more sessions over combining anti-VEGF with complete PRP in 2 or more sessions.

Respondents in Central and South America favored the combination treatment just slightly over PRP alone (42.7% to 40.4%, respectively), while respondents in the U.S. clearly preferred the combination treatment over PRP alone (37.7% to 29.3%, respectively).

**Overall anti-VEGF use**

If there is an absence of adequate response to a first-line anti-VEGF, every region overwhelmingly opts to switch to a different anti-VEGF agent. Running a distant second preference in Africa/Middle East, Central and South America, and Europe is to switch to a steroid alone. In Asia-Pacific and the U.S., respondents also opt to use a steroid in combination with anti-VEGF agents. For the purposes of this survey, “adequate response” was not defined, which may account for the varied secondary responses.

Based upon results from the Diabetic Retinopathy Clinical Research Network (DRCR.net) Protocol T2-year study, initial treatment for a phakic patient with DME is overwhelmingly Avastin (bevacizumab, Genentech) in both Africa/Middle East and the U.S. The remaining regions of the world use either bevacizumab or Eylea (afibercept, Regeneron) as their first-line treatment choice.

**Angiography**

In every region of the world except the U.S., clinicians overwhelmingly said they had access to optical coherence tomography angiography and find it useful in clinical practice. In the U.S., however, 53% of respondents do not have access to technology.

In each region of the world, there are some who have access, but do not find it useful: 23.8% in Africa/Middle East, 16.7% in Asia/Pacific, 16.5% in Central and South America, 13.1% in Europe, and 18.9% in the U.S.

**Anesthesia use**

Before giving intravitreal injections, respondents opt to use anesthesia. The type varies across regions. In Africa/Middle East, respondents preferred anesthetic drops slightly more than topical anesthetic applied with a pledget (46.9% to 40.8%, respectively). In Asia-Pacific, Central and South America, only anesthetic drops were chosen (by 83.7%, 79.8% and 91.6% of respondents, respectively).

In the U.S., however, responses were fairly even between anesthetic eyedrops (22.8%), topical anesthetic gel (23.9%), an injected agent (33.6%). Of potential interest is that no other region of the world opts for either topical anesthetic gels or injected agents.

**Pseudophakic patients**

Respondents were also asked about their preferences for treatment if they needed a secondary intraocular lens (IOL) without capsular support. In Asia/Pacific and Central and South America, the preference is to use an IOL sutured to the sclera (49.6% and 47.9%, respectively).

In Asia-Pacific, respondents also opt to use a sutureless IOL fixated to the sclera (23%) and an anterior chamber IOL (13.9%); in Central and South America, 30% opt to use a sutureless IOL fixated to the sclera and 9.4% opt for an anterior chamber IOL.

Using a sutureless IOL fixated to the sclera is the overwhelming preference for those in Africa/Middle East (60.3%), followed by an IOL sutured to the sclera (20.6%) and an anterior-chamber IOL (8.3%). Europeans also prefer a sutureless IOL fixated to the sclera (32.3%), but are then equally split in choosing something else or an IOL sutured to the iris (17.3% each).

In the U.S., anterior chamber IOLs are most often preferred (34.7%), followed by a sutureless IOL fixated to the sclera (27.5%) and an IOL sutured to the sclera (27.1%).
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Research highlights the ABCs of VEGF treatment for DME

SWAP-TWO study shows anatomic improvement after switch to aflibercept

By Michelle Dalton

For patients with diabetic macular edema (DME), intravitreal anti-vascular endothelial growth factor (VEGF) agents have become the first-line treatment. There are currently only two VEGF inhibitors approved for use in the United States for the treatment of DME: aflibercept (Eylea, Regeneron) and ranibizumab (Lucentis, Genentech). Bevacizumab (Avastin, Genentech) is often used off-label, and pegaptanib (Macugen, Bausch + Lomb) has declined in use since the introduction of both aflibercept and ranibizumab.

Numerous clinical trials have shown both visual acuity (VA) and anatomic outcomes can be improved with the use of the anti-VEGFs, yet reports of persistent DME remain despite continuous anti-VEGF therapy. Extension studies of RESTORE, RISE and RIDE all show a decline in VA when patients were transitioned to a more flexible treatment after being on a fixed dosing regimen.1, 2

The SWAP-TWO study[3] was a prospective, interventional, single-arm study (Cole Eye Institute) that enrolled 20 eyes of 20 patients between December 2015 and August 2017 to evaluate the effects of switching patients with DME to aflibercept after being previously treated with other anti-VEGF agents; the study also placed these patients on a fixed dosing regimen. This initial 6-month interim analysis suggests switching agents can substantially improve anatomic outcomes while maintaining vision gains.

In SWAP-TWO,3 eligible participants were aged ≥18 years with foveal-involving retinal edema secondary to diabetic retinopathy (DR) based on investigator review of clinical exam and spectral-domain optical coherence tomography (SD-OCT) with central subfield thickness of 325 µm, best-corrected visual acuity (BCVA) of 20/25 to 20/400 in the study eye, and history of previous treatment with bevacizumab or ranibizumab with at least 4 previous injections in the last 6 months.

Patients were excluded if they had a history of aflibercept use, or if they had used systemic anti-VEGF therapy in the 3 months prior to enrollment.

The average age at screening was 63.7 years, 13 enrolled subjects were female (65%), and the average number of prior injections was 4.25 during the 6 months prior to study enrollment.

Nine of the eyes were considered to have moderate DR severity, and the mean central subfield thickness was 419.7 µm in the study eye. The majority of patients had been treated with bevacizumab (95%).

‘Overall, this study begins to offer useful clinical insights into switching anti-VEGF medications followed by extended treatment intervals of aflibercept.’ – SWAP-TWO authors

Patients were administered 2 mg (0.05 ml) of intravitreal aflibercept administered monthly until there was no evidence of fluid as determined by OCT. (For this study, “no evidence of fluid” was considered to include lack of subretinal fluid, a central subfield thickness of < 320 µm, or a foveal cystoid macular edema with focal depression present or with fovea flat.)

Patients were administered fixed aflibercept once every 2 months; “failure” was defined as a loss of 15 or more ETDRS letters from the best previous measurements and an increase of 75 µm compared to the previous visit measurement. The investigators allowed an additional treatment with aflibercept for those patients.

The primary outcome of the study was defined

IN SHORT

》 The SWAP-TWO study enrolled 20 eyes of 20 patients to evaluate the effects of switching patients with DME to aflibercept.
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as the mean absolute change from baseline central foveal thickness at month 12 with pre-planned interim analysis as measured by SD-OCT (defined as the average thickness within the central 1 mm subfield) at month 6. Secondary outcomes included the efficacy of treatment outcomes by improvements in ETDRS BCVA from baseline, perfusion changes in OCTA before and after therapy, as well as safety and tolerability of aflibercept therapy by monitoring adverse events.

Patients received an average of 5.25 injections over an average of 5.3 visits. (Fellow eye injections averaged 2.15 in 65% of patients.) At month 6, 11 patients (55%) still needed monthly treatment, while nine patients were able to move to q2 month dosing after an average of 3.3 injections with aflibercept. Central subfield thickness improved from 419.7 ± 92.0 (328–585) μm at baseline to 303.8 ± 73.1 (198–485) μm at month 6 (27.63% reduction). Each subsequent visit had statistically significant improvement in central subfield thickness from baseline (p < 0.001 for all time-point comparisons).

Throughout the study period, no change in DR severity was observed. Two patients had epiretinal membrane at baseline and no visual change was seen at 6 months. BCVA increased minimally between the baseline visit and 6 months; [70.0 ± 7.2 (60–81) to 71.5 ± 8.9 (54–83) letters], but this change was not statistically significant (p = 0.38). At baseline, 65% (n = 13) patients were 20/40 or better, 35% (n = 7) patients were 20/50 or worse, and no patients were 20/200 or worse. By the end of month 6, 12 patients (60%) were 20/40 or better, eight patients (40%) patients were 20/50 or worse, and no patients were 20/200 or worse. SWAP-TWO found “significant anatomical improvements” could be achieved when switching patients to aflibercept from other anti-VEGF agents. The study confirms findings from other retrospective studies, the authors noted, where significant anatomic improvement without BCVA gains have been reported. “Overall, this study begins to offer useful clinical insights into switching anti-VEGF medications followed by extended treatment intervals of aflibercept,” the authors wrote.³ “The 12-month results of this study will be helpful in determining whether vision does indeed improve with continued treatment. If fixed-dosing at a longer interval once macular fluid is resolved can sustain these positive effects.”

REFERENCES
Evidence from randomised clinical trials and real-world studies supports the effectiveness of anti-vascular endothelial growth factor (anti-VEGF) therapy using a treat-and-extend (TAE) regimen for neovascular age-related macular degeneration (nAMD).

Twelve-month results from the TREND study have suggested that ranibizumab given using a TAE regimen for nAMD was clinically comparable to monthly ranibizumab in improving VA from baseline.¹

The mean best corrected visual acuity (BCVA) change from baseline to month 12 was +6.2 letters in the TAE arm versus 8.1 letters in the monthly regimen arm.

Significantly fewer injections and visits were required in the TAE group compared with the monthly regimen group. In the ALTAIR study of aflibercept using a variable TAE protocol for treatment-naïve nAMD patients (n=246), rapid and substantial improvements in visual and anatomic outcomes observed during the first 6 months were largely maintained through 2 years of extended interval dosing.²

The mean BCVA improvements from baseline were up to 9.0 letters at week 52 and up to 7.6 letters at week 96.

Approximately 30% of eyes gained at least 15 letters from baseline at weeks 52 and 96.

There was no statistically significant difference between ranibizumab and aflibercept in the mean change of BCVA from baseline to month 12 or to month 24 in the RIVAL study, the first prospective randomised controlled trial to compare the efficacy of these anti-VEGF agents using an identical regimen for treatment-naïve nAMD patients (n=281).³,⁴

The mean number of injections and retinal thickness improvements over 24 months were similar for both agents, with comparable safety results.

The proportions of TAE participants achieving a maximum treatment interval of 12 weeks or longer was 22.3% in TREND at 1 year, ≥57% in ALTAIR at week 96 and 31–32% over 24 months in RIVAL.⁴

‘Ranibizumab given using a TAE regimen for nAMD was clinically comparable to monthly ranibizumab in improving VA from baseline.’

– TREND study

The author speaks to Professor Mark Gillies, principal investigator of the RIVAL study, to learn more about anti-VEGF TAE approaches to the management of nAMD. He also is director of research, Save Sight Institute, The University of Sydney, Sydney Eye Hospital, Sydney, Australia.

How well does TAE work?

“TAE using intravitreal anti-VEGF therapy is a feasible and effective approach for the management of nAMD in routine clinical practice and can achieve outcomes that are close to those observed in pivotal registration clinical trials. “Fixed dosing with regular monthly or bimonthly retreatment is often not necessary for patients, meaning that a variable treatment regimen is followed, and that means being proactive or reactive.

“A reactive pro re nata (PRN, as needed) approach to anti-VEGF treatment for nAMD just hasn’t worked in practice, not least because few

In Short

✗ Treat-and-extend with intravitreal anti-VEGF therapy is arguably the most effective approach to the management of nAMD in real-world practices, says Prof. Mark Gillies.
centres currently have the capacity or resources to provide regular monthly monitoring.

“Studies consistently show that, with PRN treatment, patients have more visits, fewer injections and worse outcomes compared with alternative treatment regimens. TAE approaches, on the other hand, consistently achieve better outcome results than PRN treatment in real-world studies of anti-VEGF therapy for nAMD.”

“If you extend gradually you quite quickly find the break-point with respect to treatment interval extension and lesion activity.’

– Professor Mark Gillies

What lessons do you draw from TAE studies of anti-VEGF therapy for nAMD?

“Randomised controlled clinical trials represent an ideal world, but ultimately it is what you can achieve in the real world which is important.

“The Fight Retinal Blindness outcome registry reveals what can be achieved in routine clinical practice.

“Over 24 months of follow-up treatment, aflibercept is given to the patient using a TAE regimen achieved good visual outcomes, with an improvement from baseline of 6.0 ETDRS letters, while decreasing the number of injections and clinic visits from the first to second year of treatment. 6

“Further, a meta-analysis of real-world observational studies of ranibizumab therapy for nAMD (~26,360 patients) demonstrated patients receiving a TAE regimen achieve better visual acuity outcomes with more injections but fewer visits than those receiving PRN treatment. 5

“The mean change from baseline in visual acuity at 2 years was +6.7 for patients receiving a TAE regimen compared with +1.3 letters for PRN treatment.”

What approach do you take using a TAE protocol for nAMD?

“Using a TAE strategy for nAMD, we aim to treat at each clinic visit and practitioners on average treat patients at around 80% of all visits. If you extend gradually, you will quite quickly find the break-point with respect to treatment interval extension, and lesion activity. “Once you have identified the optimal treatment interval that maintains stable exudative disease, it is remarkable how constant that remains for many patients you will encounter.

“A TAE regimen strategy helps ensure patients remain under control the whole time.

“In my experience, around 20% of patients will remain on 4-weekly retreatment after the initial treatment loading phase and up to 30% or greater are extended through to 12-weekly treatment intervals, with an 8-weekly retreatment interval being the most common injection interval maintained longer term.

“In Australian practice, the average number of treatments for newly diagnosed nAMD during the first year is about seven, followed by five injections during each year thereafter.

“Two-year results from the FLUID study suggest that it may be possible to tolerate a small amount of remaining subretinal fluid (SRF) (≤200 µm at the foveal centre) and still maintain or extend the treatment interval without a detrimental effect on vision outcomes.”

“Registry outcome data from Australia support previous study findings suggesting that the presence of SRF on optical coherence tomography may have a protective effect against the potential development of macular atrophy.

“I think it is desirable to have a certain degree of SRF, the real question is how much.”

REFERENCES


PROF. MARK GILLIES, MB BS, PHD, FRANZCO
E: mark.gillies@sydney.edu.au
Dr Gillies has no relevant interests to disclose.
Table 1. TAE RCTs and real-world studies of aflibercept and ranibizumab for neovascular AMD: treatment frequency and vision outcomes Years 1 and 2.

<table>
<thead>
<tr>
<th>Study</th>
<th>Aflibercept (Injections)</th>
<th>Ranibizumab (Injections)</th>
<th>Aflibercept (BCVA)</th>
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*2-week adjustment TAE group; †4-week adjustment TAE group. Abbreviation: BCVA, best corrected visual acuity, measured as Early Treatment Diabetic Retinopathy Study letter score; RCTs, randomised clinical trials.
Successful presbyopia correction after hyperopic LASIK using the AT LARA EDoF IOL

By Dr. Claudio Orlich – San José, Costa Rica

CASE HISTORY

A 62-year-old woman presented because of decreased vision. She had undergone hyperopic LASIK 12 years earlier at a different institution, and now she wanted another refractive procedure to regain spectacle independence. Examination showed incipient nuclear sclerosis in both eyes (OU). In the right eye (OD), uncorrected visual acuity (UCVA) was 20/150, best corrected visual acuity (BCVA) was 20/25, and manifest refraction (MR) was +4.25 -1.00 X 30. In the left eye (OS), UCVA was 20/100, BCVA was 20/25, and MR was +4.00 -1.00 x 155 with an addition of +2.25 D. Corneal asphericity measurements showed Q coefficients of -0.64 OD and -0.50 OS, consistent with the hyperopic ablation that causes central steepening and makes the cornea more prolate. The patient was counseled about the possibility of a postoperative refractive surprise because of her history of LASIK. Different IOL options were discussed, including monovision with a spherical IOL and bilateral implantation of the aberration-neutral AT LARA 829MP extended depth of focus (EDoF) IOL. The patient chose the AT LARA IOL.

IOL power was determined using biometry measurements obtained with the IOLMaster 700 (Carl Zeiss Meditec) and the PANACEA IOL calculator (http://www.panaceaio1andoricalculator.com/downloads.html) based on a target refraction of -0.25 D OU. Surgery was performed with the primary incision made on the steep corneal meridian and paired with a clear corneal incision 180° away to achieve astigmatism correction. Intraoperative aberrometry (ORA, Alcon Laboratories) confirmed the preoperatively selected IOL powers. At 1 month after the second eye surgery, MR was -0.25 -0.50 x 150 OD and -0.25 -0.25 x 45 OS. The patient’s UCVA was 20/20 at distance OU and J1 between 40 and 60 cm. Total spherical aberration (SA) was close to 0 in both eyes (-0.054 µm OD, -0.027 µm OS).

DISCUSSION

Millions of people worldwide have undergone excimer laser vision correction surgery. Having experienced the advantages of not wearing glasses, these patients are motivated to invest in a refractive procedure when they develop presbyopia or cataract. However, there are challenges for delivering good visual acuity and good visual quality outcomes that are necessary for patient satisfaction. Avoiding residual refractive error is critical for achieving good visual performance with multifocal IOLs, but accurate IOL power calculation is difficult in eyes with previous refractive surgery. Illustrating this problem, Muftuoglu et al. reported a 42.9% laser enhancement rate after multifocal IOL implantation in a series of 49 eyes with prior myopic LASIK.

In addition, some patients have persistent dry eye after LASIK that affects accurate IOL power calculations as well as visual quality. Not surprisingly, dry eye is reported as a leading cause of dissatisfaction after multifocal IOL implantation. Because of the relationship between higher-order aberrations (HOAs) and quality of vision, changes in corneal HOAs after keratorefractive surgery is another important consideration. As one issue, keratorefractive procedures tend to induce corneal aberrations and multifocality, leading to decreased contrast sensitivity that would be further compromised by multifocal IOL implantation.

In addition, the effect of prior refractive surgery on spherical aberration (SA) requires particular attention. Because SA reduces retinal image contrast and affects visual quality, especially under mesopic conditions, most modern IOLs feature an aspheric optic that induces negative SA, thereby minimizing total SA by compensating for the slightly positive SA (+0.27 µm) of the natural cornea.²⁻³ Whereas a keratorefractive surgery for correcting myopia causes corneal SA to become more positive,⁴⁻⁵ Implanting an aspheric IOL with negative SA in an eye with a history of hyperopic LASIK could worsen the existing negative SA and be expected to have an adverse effect on quality of vision.

Taking the above mentioned factors into account, the AT LARA EDoF IOL can be considered a better choice than a multifocal IOL for pseudophakic correction in patients with a history of corneal refractive surgery. The AT LARA has an aberration-neutral optic with zero SA, provides excellent visual acuity over a wide range of focus from far to near intermediate distances, incorporates patented design and manufacturing technology that reduces visual symptoms, and features chromatic aberration optimization for increased contrast sensitivity. In addition, the EDoF optic of the AT LARA IOL allows for some tolerance to residual refractive errors. We
hyperopic LASIK using the AT LARA EDoF IOL

Successful presbyopia correction after

CASE OF THE MONTH

By Dr. Claudio Orlich – San José, Costa Rica

Millions of people worldwide have undergone excimer
day activities, including reading. A laser enhancement
was necessary in only one eye; this rate of just 7.1%
compares very favorably with the incidence of 42.9%
reported by Muftuoglu et al.1

We believe that the PANACEA calculator is particularly useful for IOL power calculations in eyes with previous refractive surgery because it uses information on anterior and posterior corneal surface and corneal asphericity. Nevertheless, given the known difficulties of estimating the IOL power in these cases, we aim for a slightly myopic target refraction (-0.25 to -0.50 D; usually the first negative value in the IOL power calculation). The average postoperative refraction achieved in our series of 14 eyes with a history of hyperopic LASIK was -0.3D, and although we found it was associated with very good functional outcomes, other surgeons might prefer choosing a target closer to emmetropia. It should be noted, however, that we do not perform simultaneous bilateral surgery. By operating on just one eye first, we can adjust the refractive target in the second eye depending on the patient’s satisfaction with vision after the first eye surgery.

Appropriate preoperative counseling is critical for setting patient expectations. Patients are told that quality distance and intermediate vision is the greatest strength of the AT LARA EDoF IOL and that glasses with a low addition may be needed for reading. They are also informed about the possibility of an inaccurate IOL power calculation with the need for a laser enhancement. We have found, however, that intraoperative aberrometry can be an extremely useful tool for obtaining excellent refractive and functional results in these cases to avoid a second procedure.

CONCLUSION

Achieving consistently excellent results implanting the AT LARA IOL in patients with virgin corneas gave us the confidence to use it in the more challenging group of patients with prior keratorefractive surgery. The SA-neutral optic of the AT LARA makes it particularly well-suited for use in patients with a history of a hyperopic refractive procedure, but the AT LARA IOL has many advantages that make it an excellent option in patients with prior myopic LASIK. In all cases of virgin and operated corneas, careful candidate selection and preoperative counseling are critical for achieving success and patient satisfaction postoperatively.

References

Dr. Claudio Orlich. Dr. Orlich is the Medical Director of Clínica 20/20, San José, Costa Rica, where he specializes in corneal and refractive surgery. He is a consultant to Carl Zeiss Meditec.
Surgeons eye letter-perfect outcomes with new extended depth of focus IOL

By Fred Gebhart; Reviewed by Dr Julie M. Schallhorn

Early data show generally positive outcomes following bilateral implantation of a new extended depth of focus (EDOF) intraocular lens.

A retrospective analysis of clinical and patient reported outcomes 3 month after bilateral implantation of the Zeiss AT Lara 829MP (Carl Zeiss Meditec AG) in 293 patients found that 86.7% of eyes were within 0.50 D of emmetropia.

Most patients, 95.4%, were spectacle-free for distance vision and 83.6% were spectacle-free for near vision.

“This is the first cohort of patients who have had this lens implanted at Optical Express,” said Julie M. Schallhorn, MD, MS, assistant professor of ophthalmology at the University of California, San Francisco. “Especially in our younger patients, in their 50s and 60s, so much of our lives are on our phones and tablets. Having a lens that can give you that phone vision and tablet vision without sacrificing distance vision is very, very attractive for patients.”

The analysis includes all patients from September 2017 through September 2018 who returned for their 1-week, 1-month and 3-month post-op visits. Dr Schallhorn is senior author for an article published in the Journal of Refractive Surgery. A longer-term evaluation of both clinical and patient reported outcomes is currently under way.

Dr. Schallhorn pointed out that while the AT Lara lens has not yet been approved for use in the United States, it is currently approved for use in the European Union and other jurisdictions. It is a hydrophilic IOL with 25% water content and a hydrophobic surface.

The device has four-point haptic fixation, 6-mm optic diameter, 11-mm overall length and is available in a range of ~10.00 to +32.00 D in 0.50 D increments. A toric version of the lens (AT Lara 929MP) is also available but was not used in this cohort.

The AT Lara is based on a diffractive principle. It is aspheric, aberration-neutral and chromatic aberration-correcting to provide a progressive visual field across three focal points: distance, 1.90 D for far-intermediate and 0.95 D for near-intermediate distances.

All of the patients in the analysis had bilateral implantation with no prior history of refractive surgery and no ocular comorbidities other than refractive error or cataracts.

Of the patients, 232 (79.2%) underwent implantation for refractive correction while 61 patients (20.8%) had cataracts, most often mild, with CDVA no worse than 20/32. The mean age of the cohort was 59 with a slight preponderance of men, 54%.

The mean preop sphere was +1.50 D, mean cylinder was −0.51 D and the mean manifest spherical equivalent was +1.24 D.

“With any new lens, you want to see how it performs in your average, everyday patient off the street,” Dr. Schallhorn said. “How they like it, how it is working for them. That is why we did this retrospective evaluation.”

IN SHORT

» New extended depth of focus lenses offer potential, but will require careful patient selection and counseling in terms of near vision results and the potential for optical side effects.
Three months after implantation, 86.7% of eyes were within ±0.50 D of emmetropia and 98.3% were within ±1.00 D of emmetropia.

The mean MSE was –0.05 D with a coefficient of determination of 0.96. The mean prediction error, the difference between the predicted MSE and the achieved MSE, was –0.07.

Most of the eyes, 90.8%, had monocular UDVA of 20/25 or better at three months and all eyes had CDVA of 20/25 or better. Just over half of eyes, 57.5%, had the same UDVA after surgery as the CDVA before surgery. Nearly all patients, 97.4%, had binocular UDVA of 20/25 or better.

Uncorrected near vision at 40 cm was expectedly less than distance vision, Dr. Schallhorn said, as the EDOF lens has a near focal point of about 60cm.

According to the researchers, a solid majority of the eyes, 84.6%, had monocular UNVA of 20/50 or better at 3 months and all eyes had CDVA of 20/25 or better. Just over half of eyes, 57.5%, had the same UNVA after surgery as the CDVA before surgery. Nearly all patients, 97.4%, had binocular UNVA of 20/50 or better.

There were no serious or unexpected adverse events associated with the lens. There were no explants during the first three postop months and none of the patients declined the AT Lara implant for their second eye, according to researchers.

Patient reported outcomes were generally very favorable. Two-thirds of patients (66.6%) completed a patient experience questionnaire at 3 months, down from 85% preoperatively and 69.6% at 1 month.

Most patients, 90.3%, said they were satisfied or very satisfied with their new vision, Dr. Schallhorn reported.

‘But multifocal lenses come with more symptoms. We see a very good potential for this lens, but it will require careful patient selection and counseling in terms of near vision results and the potential for optical side effects.’

Dr Julie M. Schallhorn

Patients like multifocal lenses,” Dr. Schallhorn said. “We have seen that in study after study. But multifocal lenses come with more symptoms. We see a very good potential for this lens, but it will require careful patient selection and counseling in terms of near vision results and the potential for optical side effects.”

JULIE M. SCHALLHORN, MD, MS

This article is based on Dr. Schallhorn’s presentation at the 2019 American Society of Cataract and Refractive Surgery annual meeting. Dr. Schallhorn has no financial disclosures to report.
Why remove an IOL? Survey brings key trends into focus

While some IOL explantations are inevitable for cataract surgeons, with good surgical technique, accurate lens measurements, and proper patient selection and preoperative counselling, physicians can lower their explantation rate.

Nick Mamalis, MD, professor of ophthalmology, codirector of the Intermountain Ocular Research Center, director of ocular pathology, Moran Eye Center, University of Utah, Salt Lake City, reviewed an ASCRS/ESCRS survey delving into trends regarding explanted lenses.

The survey inquired about patients’ preoperative and postoperative visual acuity, any signs or symptoms and complaints, and complications that required IOL removal, exchange, or secondary intervention.

Surgeons were asked about explantation of the following IOL types: one-piece, plate-type; one-piece IOLs with haptics, three-piece IOLs; multifocal IOLs, and accommodating lenses.

The materials used in the lenses mentioned were silicone, acrylic (hydrophobic), hydrogel (hydrophilic acrylic), and collamer.

As in previous years, the lens with the highest rate of explantation was the one-piece hydrophobic (monofocal) lens. However, this is also the most common type of lens used in the United States, which would explain why it is removed most frequently, Dr. Mamalis said. (Figure 1)

Other materials are not removed as often because they are used less often in patients, Dr. Mamalis explained.

Dislocation and decentration were the most common complications associated with one-piece silicone IOLs, followed by glare/optical aberrations and incorrect lens power. Dislocation and decentration also were the most common reasons for removal of three-piece silicone and one-piece acrylic lenses, Dr. Mamalis reported.

This complication is usually linked to a surgical complication or weakness in the zonules or the capsular bag, he explained.

Other common reasons for lens removal among various lens types included incorrect lens power and glare/optical aberrations. Incorrect lens power still was a cause of IOL removal in the survey, but this has trended downward in recent years, leading Dr. Mamalis to say that surgeons are getting better

COMMON COMPLICATIONS WITH ONE-PIECE SILICONE IOLS:

> Dislocation
> Decentration
> Glare/optical aberrations
> Incorrect lens power

‘Proper patient selection could help reduce the number of multifocal IOL patients requiring lens removal.’

– Dr Nick Mamalis

IN SHORT

Accurate IOL measurements, proper patient selection, and solid surgical technique can help to reduce the number of IOL explantations.
at choosing the correct IOL power.

The number of multifocal IOLs that were explanted increased over the past year, and this was most frequently due to glare/optical aberrations. Proper patient

selection could help reduce the number of multifocal IOL patients requiring lens removal, he said.

Calcification and opacification were the most common reasons that hydrophobic acrylic IOLs were explanted.

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**NICK MAMALIS, MD**

E: nick.mamalis@hsc.utah.edu

This article was adapted from Dr Mamalis’s presentation at the 2019 American Society of Cataract and Refractive Surgery annual meeting in San Diego. Dr Mamalis is a consultant for Alcon Optics and PerfectLens. He also does research for a variety of ophthalmic companies.
The path to learning ocular surgery is a long and challenging one, but it is enjoyable and worth the investment to bring sight to our patients.

True success requires years of dedication and the passion to consistently learn from every case and evolve your technique every year.

Acquiring surgical skills

During the years of residency and fellowship training, basic surgical skills are acquired relatively quickly and the fundamental techniques and procedures are learned. Because this part of the learning curve is the steepest, there is a frustration barrier that must be overcome to get your hands to do what you need.

No one is born knowing how to suture with 10-0 nylon monofilament, so extensive practice in the wet lab is instrumental in learning.

Similarly, manual dexterity must be developed in both hands with particular attention paid to bring the non-dominant hand up to par with the dominant hand. Modern day cataract surgery is two-handed, and the older, one-handed techniques are not as safe or efficient.

The blue line in our graph is the young doctor who cannot find the drive to push past the frustration barrier to become an ophthalmic surgeon. As such, this doctor will drop out of training, switch to a different medical specialty, or choose to be a medical dropout.

The green line in the graph is the expert surgeon who has the drive and determination to learn from every single case and consistently evolve surgical techniques over the years.

IN SHORT

» We can all become true experts by channeling the passion for ocular surgery, according to Dr Uday Devgan, a surgeon based in Los Angeles, CA.

By Dr Uday Devgan

We can all become true experts by channeling the passion for ocular surgery, according to Dr Uday Devgan, a surgeon based in Los Angeles, CA.

» We can all become true experts by channeling the passion for ocular surgery, according to Dr Uday Devgan, a surgeon based in Los Angeles, CA.

Understanding the surgical learning curve one case at a time

True success requires years of dedication, as well as passion.
ophthalmologist who does not perform surgery.

Completing residency training will allow the ophthalmologist to acquire a reasonable surgical skill set and to become a competent surgeon, but not to become a true expert with the highest level of surgical skill and judgment.

The red line in our graph is the surgeon who is able to get past the frustration barrier and become a competent surgeon. But, for these surgeons, the passion and the drive to be better, simply is not there. This doctor will be stuck in this zone of mediocrity forever and will simply do the techniques that were learned back in residency training.

We have all seen the surgeons who continue to perform older, outdated procedures because that is what they learned decades ago and that is where their comfort level lies.

“We have all seen the surgeons who continue to perform older, outdated procedures because that is what they learned decades ago and that is where their comfort level lies.”

— Dr. Uday Devgan

The critical question to ask is, “Am I doing the best for my patients and am I giving the surgery that I would want to receive?”

Becoming a true expert requires the surgeon to have a passion for ocular surgery and then to continue to learn independently for many years to come. Much more will be learned in the years after residency and fellowship compared to during the formal training.

Drive to go green

The green line in our graph is the expert surgeon who has the drive and determination to learn from every single case and consistently evolve surgical techniques over the years. This surgeon embraces the very difficult cases and prepares diligently for them. This surgeon also has the passion to be the best and will maintain that passion for decades. This is the true expert.

Getting to the mountaintop is never easy, and would-be surgeons learn this from the first day.

There is an incredible amount to learn in the first few years in practice. Having senior colleagues and partners are helpful in providing mentorship both in and out of the operating room.

A large portion of surgical success is pre-operative planning and discussions with patients, as well as post-operative management.

Once we are able to push through this passion barrier, we will want to do more of the tough surgical cases because we will enjoy the challenge.

Conclusion

And then finally, when we are widely considered master surgeons and true experts in the field, we will still keep up with learning from every surgery and further advancing our skills.

We can all become true experts by channeling the passion that attracted us to ocular surgery. We must learn from each and every surgery that we perform.

As surgeons, we also need to keep up with the latest techniques and technologies through continuing medical education and collaboration with colleagues.

We understand that our field keeps evolving from day to day and the way that we operate today may not be the preferred technique in the future.

When it comes time for me to have surgery on my body, be it cataract surgery, orthopedic surgery, or cardiac surgery, I want a true expert who has the passion to be the best. I’m sure you feel the same.

DR UDAY DEVGAN, MD, FACS
E: devganug@gmail.com
Dr. Devgan is in private practice at Devgan Eye Surgery in Los Angeles and Beverly Hills. He is clinical professor of ophthalmology at the Jules Stein Eye Institute at the UCLA School of Medicine and Chief of Ophthalmology at Olive View-UCLA Medical Center.

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Patients who received the AcrySof PanOptix IOL (Alcon) with its new diffractive trifocal design have achieved satisfactory vision at all distances with a high rate of spectacle independence and very little photic phenomena, according to Yonca A. Akova, MD, FEBO.

The IOL is a one-piece, aspheric, non-apodized diffractive hydrophobic lens with a 4.5-mm central trifocal zone and 15 diffractive zones. It has adds of +3.25 D for near vision and +2.17 D for intermediate focus.

Dr Akova, professor of ophthalmology, Bayındır Hospital, Ankara, Turkey, and her coinvestigators conducted a prospective, non-comparative, non-randomised study to evaluate the refractive and visual outcomes and satisfaction levels of 69 patients (40 men, 29 women; mean age, 64.5 years) after bilateral implantation of the IOL during cataract surgery or refractive lens extraction. The surgeries took place from October 2017 to June 2018. Patients underwent ophthalmologic examinations preoperatively and 6 months postoperatively.

The primary outcome measures were the manifest refraction; uncorrected distance visual acuity (UCVA), intermediate VA (UNVA) at 60 cm, and near VA (UNVA) at 40 cm; defocus curves, dysphotopsia, spectacle independence, posterior capsular opacification (PCO), and the results of the visual function test-14 (VF-14), according to Dr Akova.

Six-month results

The investigators reported that at 6 months postoperatively mean UCVA was 0.02 logarithm of the minimum angle of resolution (logMAR); all patients had 0.3 logMAR or higher visual acuity and 97.1% had 0.1 logMAR or higher. The mean UNVA was 0.06 logMAR; all patients had 0.2 logMAR or higher and 75.4% had 0.1 logMAR or higher. The mean UNVA was 0.05 logMAR; all patients had 0.2 logMAR or higher and 82.6% had 0.1 logMAR or higher.

Regarding the defocus curves, the average VA was 0.1 logMAR or better between +0.05 to -3.00 D. Two peaks were seen at 0.00 D and -1.50 D. These results were similar to those reported previously.

Optical phenomena reported by patients were mild nondisturbing halos in 43.4%, mild glare in 14.4%, disturbing halos in 1.4% upon questioning, and mild PCO in 5%, with Nd:YAG capsulotomy necessary in one eye. The mean VF-14 test score was 97.7. The majority of patients, 84.2% reported complete spectacle independence.

The combination of good visual outcomes and spectacle independence of disabling photic phenomena are the main reasons for the high levels of patient satisfaction and the VF-14 test scores.’

– Dr Yonca A. Akova

Study comparison

Dr. Akova reported that compared with published studies of the PanOptix IOL, non-disturbing halos were reported by 57.6% in the study under discussion compared with 15% to 95% in the other studies.

The rate of spectacle independence in this study

IN SHORT

The AcrySof PanOptix diffractive trifocal intraocular lens has achieved excellent vision at all distances with a high rate of spectacle independence and importantly little photic phenomena.
was 94.2% compared with rates ranging from 94.8% to 95% in other studies.
All current patients scored 93 points or higher on the VF-14 test, which was out. The information that was added to the knowledge about this IOL was that its bilateral implantation provided excellent visual outcomes at all distances with a

‘Patients who receive the AcrySof PanOptix IOL with its new diffractive trifocal design achieved satisfactory vision in all distances with a high rate of spectacle independence and very little photic phenomena.’

Dr Yonca A. Akova

a similar result to those reported in the literature. In addition, the current UDVA, UDVA, and UNVA were similar to previous studies and slightly better than those reported by Alio et al. in 2018 and slightly below those reported by Kohnen et al. in 2017.12

“The combination of good visual outcomes and spectacle independence with a low incidence of disabling photic phenomena are the main reasons for the high levels of patient satisfaction and the VF-14 test scores,” Dr Akova said.

The study provided the clinical outcomes achieved with the PanOptix IOL with the largest sample size, she pointed high rate of spectacle independence. The lens has CE Mark approval.

REFERENCES

DR YONCA A. AKOVA, MD, FEBO
 kc.yoncaakova@yahoo.com
 The authors had no financial interest in any aspect of this report.
Employees of medical marijuana dispensaries advocate the use of marijuana for treating glaucoma, a position that is counter to recommendations of the American Glaucoma Society (AGS) and current glaucoma literature. When it comes to the treatment of glaucoma, patients should be properly educated during clinical encounters about marijuana.

The use of medical marijuana by adults more than doubled in the United States between 2001 and 2013 with the legalisation of the drug in a number of states across the country, one of the first of which was Colorado in 2000.

In 2009, a position paper issued by the AGS advised against the use of marijuana for treating glaucoma. However, patients continue to ask about the drug’s possible benefits, according to Jordan Stanley, MD, an instructor/fellow, department of Ophthalmology, University of Colorado School of Medicine, Anschutz Medical Campus, Aurora, CO.

The study
To assess recommendations that employees of medical marijuana dispensaries are giving patients who may consider marijuana as an option to treat their glaucoma, Dr Stanley and colleagues conducted a study in which dispensaries were called by a person posing as a patient with glaucoma. The primary study outcome was the number of dispensaries that recommended a product containing marijuana for the treatment of glaucoma.

In the study, investigators randomly selected 60 medical marijuana dispensaries to call from the website of the Colorado Department of Revenue Enforcement Division.

In each instance, the caller identified themselves as a patient with glaucoma, and asked questions about marijuana use for glaucoma while working from a prepared script.

The questions focused on products recommended for glaucoma treatment, recommended methods, safety, and whether they should talk to their doctor, Dr Stanley explained.

The findings
When asked about the availability of marijuana products recommended for treating glaucoma, the investigators reported that 35 (58%) of the dispensaries recommended using marijuana, and 25 (42%) dispensaries deferred from making a recommendation.

When the employees were asked about the recommended method of use, 45% recommended using the sublingual tincture, 21% edible consumption, 20% no preference, and 14% suggested inhalation.

When questioned about the safety of the products, 78% claimed that the marijuana products were safe, and 22% deferred from making a recommendation.

Finally, when the caller asked about the need to contact his or her eye doctor for a recommendation, 38% responded yes, 35% claimed that was optional, 17% recommended contacting a marijuana doctor, and 10% responded no.

“Our findings highlighted the importance of patient education during clinical encounters regarding marijuana use as a glaucoma treatment,” Dr Stanley concluded. “Despite the recommendations of the AGS and the current glaucoma literature, the majority of employees of medical marijuana dispensaries in Colorado recommend marijuana for treatment of glaucoma.”

REFERENCE

Dr Jordan Stanley, MD
jordan.stanley@ucdenver.edu
Dr Stanley has no financial interest in any aspect of this report.
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Facing challenge of corneal infection management in operated eyes

Early identification, aggressive treatment critical to positive outcome for patients

By Cheryl Guttmann Krader; Reviewed by Dr Bennie H. Jeng.

Corneal infections involving surgical interfaces and incisions represent special situations that mandate special considerations for successful management, said Bennie H. Jeng, MD, MS.

Dr Jeng is professor and chairman, Department of Ophthalmology and Visual Sciences, University of Maryland School of Medicine, Baltimore. He discussed the issues and treatment approaches for corneal infections associated with corneal grafts, flaps, and surgical incisions.

“There is a high risk for progressive infection and/or wound dehiscence in these clinical situations,” he said. “Early identification and aggressive treatment of the infection are critical, and surgical intervention might also need to be considered.”

Penetrating keratoplasty

The inflammatory response accompanying an infectious corneal ulcer in an eye that has had penetrating keratoplasty (PK) can cause endothelial cell dysfunction and subsequently graft failure. Infection can also develop around loose sutures and lead to graft loss secondary to tissue destruction or graft dehiscence.

Use of topical corticosteroids, presence of eyelid/ adnexal abnormalities or epithelial defects, and bandage contact lens wear can also lead to late infection in eyes with a full thickness graft. Management of corneal infections in post-PK eyes includes obtaining a specimen for culture, aggressive treatment with fortified antibiotics, and consideration for reduction in topical corticosteroid use. Suture removal is needed in cases involving suture abscess.

“If the infection is large and progressive, threatening the graft-host interface, I will try to excise it en bloc and regraft the cornea if it is not responding to medical therapy appropriately,” Dr. Jeng said.

Infections that develop in a Descemet stripping automated endothelial keratoplasty or Descemet’s membrane endothelial keratoplasty interface tend to appear a few weeks to a few months after the graft procedure and usually have a fungal etiology, with Candida being the most common pathogen. In addition to the clinical appearance, confocal microscopy can be helpful for making the diagnosis. Excision of the donor lenticule and surrounding infected tissue followed by PK provides definitive treatment, but alternative management approaches have also been described.

The latter include removing the endothelial graft, irrigating the anterior chamber with amphotericin B, and then repeating the endothelial keratoplasty procedure after the infection has been adequately treated. Intrastromal injections of antifungal agents have also been suggested.

‘There is a high risk for progressive infection and/or wound dehiscence in these clinical situations.’

— Dr Bennie H. Jeng

“These infections are deep-seated, and topical and oral antifungals are not very effective treatments because they do not penetrate to the infection site when administered by these routes,” Dr. Jeng said. Infections in a deep anterior lamellar keratoplasty (DALK) interface are also most often caused by fungi.

IN SHORT

Incision infections after cataract surgery generally present within the first week and can be caused by bacteria, fungi or atypical mycobacteria. These infections are abscess-like and recommended management involves incision and scraping for culture.
Bacterial infections can also occur and usually develop in the setting of incomplete removal of infected stroma when the grafting was performed in an eye with active infectious keratitis. Confocal microscopy can aid in the diagnosis, and PK represents the most definitive treatment. Intrastromal injection of an antimicrobial agent can also be considered.

As for interface infections in endothelial keratoplasty (EK), infections in the DALK interface are deep-seated, and as such, topical and oral therapies are not usually adequate. “Irrigation of the interface after graft removal will probably not be effective because there will still be infected stromal tissue,” Dr. Jeng said.

Using keratoprosthesis

When a corneal infection develops in an eye with a keratoprosthesis, there is special concern that it will progress to involve tissue underneath the collar of the device where penetration of topically applied antimicrobial agents will be poor.

There is a risk that the infection will migrate along the stem of the optic into the eye, causing endophthalmitis. Management requires scraping to obtain a specimen for culture and smear with attention to trying to scrape underneath the device’s flange if there is involvement in that area.

Topical fortified antibiotics and antifungals should be administered. Corneal crosslinking is being investigated as a possible treatment for these infections.

“I would not hesitate to remove the keratoprosthesis and perform PK if I was concerned about perforation, endophthalmitis, or spread toward the graft-host interface,” Dr. Jeng said.

Implantation of another keratoprosthesis can be considered only after the eye has become quiet. Infections in a LASIK interface that develop within the first 1 to 2 weeks after surgery are usually caused by gram-positive bacteria, whereas atypical microorganisms (especially mycobacteria but also fungi) are the common causes of infections appearing later.

**LASIK interface**

Because LASIK interface infections are superficial, they often can be managed by lifting, scraping, and irrigating the flap.

Considering the risk for mycobacterial infection, material obtained for Gram stain and culture in eyes with a late infection should be cultured on Lowenstein-Jensen media, in addition to standard media, Dr. Jeng said.

Patients with a LASIK interface infection should also be started on fortified antibiotic drops, and a topical fluoroquinolone might be added. In cases with late presentation where there is concern about an atypical pathogen, treatment should include amikacin and discontinuation of topical corticosteroids.

For fungal infections, preferred agents are natamycin or voriconazole if the organism is a filamentous fungus while amphotericin B is used for yeast infections.

“Intervention in the worst-case scenario would be to do a therapeutic PK,” Dr. Jeng said.

Incision infections after cataract surgery generally present within the first week and can be caused by bacteria, fungi, or atypical mycobacteria. These infections are abscess-like and recommended management involves incision and scraping for culture, done in a minor room or operating room. Intensive topical antimicrobial treatment and possibly intrastromal administration of antimicrobials is indicated.

“If the infection is extending to the limbus, I would not hesitate to do an early lamellar excision if it will remove the involved tissue,” he said. “If it is too late, then the involved tissue can be removed and replaced with a small full-thickness graft.”

**DR BENNIE H. JENG, MD, MS**

E: bjeng@som.maryland.edu

Dr. Jeng has no relevant financial interests to disclose.
Providing patient-centred care is one component of improving the quality of health care, and this is more challenging in paediatric ophthalmology since both the child’s and parents’ perspectives on the eye condition and how it affects their lives have to be considered. The new Pediatric Eye Questionnaires (PedEyeQ) were developed through a collaborative effort by researchers in Minnesota and Texas to address this challenge and make outcomes measures more useful.

“The PedEyeQ has three components: a child questionnaire, a proxy questionnaire completed by the parent regarding the child, and a parent questionnaire completed by the parents regarding themselves,” said Jonathan M. Holmes, MD, Joseph E. and Rose Marie Green Professor of Visual Sciences, Mayo Clinic, Rochester, MN.

Dr Holmes and Eileen E. Birch, PhD, of the Retina Foundation of the Southwest in Dallas, led the teams that developed the questionnaire, designed to help clinicians gather patient-reported outcome measures (PROMs) on health-related quality of life and functional vision in childhood eye conditions.

In the past, instruments assessing health-related quality of life were just “made up,” Dr Holmes said, with a group of physicians devising questions that in essence told patients what should bother them rather than asking more open-ended questions and allowing patients to express what actually bothered them. A more valid approach would be to use patient-derived concerns to generate questions applicable across populations.

**Study design**

Drs Holmes and Birch and their teams took up the challenge of crafting an improved paediatric vision questionnaire by interviewing parents of children with eye conditions but also interviewing the children themselves if they were older than age 5. They asked a series of open-ended questions to 180 children across ten diagnostic categories, as well as 328 parents.

From the recorded and transcribed sessions, they identified 6,824 concerns, subsequently reduced to 569 questions that were sorted into 37 categories. Questions that were too specific were eliminated, while new summary questions were written to reduce the questions to a manageable number. This left 97 questions in the master child questionnaire.

The team’s objective from this point was to create three components or master questionnaires: one to be delivered to the child in two age-specific versions (5- to 11-year olds and 12- to 17-year-olds), a proxy questionnaire for parents to report how they perceive their child’s experience (with three age-specific versions, 0–4 years, 5–11 years, and 12–17 years), and one for the parents themselves to express their own concerns.

The questionnaires were administered to a cohort of 277 children and 444 parents. To analyse the results, the researchers used factor analysis to determine unidimensional domains within each questionnaire. This was done to avoid a pitfall common in the past, where instruments assessing health-related quality of life were just “made up,” Dr Holmes said, with a group of physicians devising questions that in essence told patients what should bother them rather than asking more open-ended questions and allowing patients to express what actually bothered them. A more valid approach would be to use patient-derived concerns to generate questions applicable across populations.

**IN SHORT**

Researchers hope questionnaire will lead to a world where patient-reported outcome measures are commonly used in pediatric eye care, not just for research but also in clinical practice.
in questionnaires in which combining two factors, such as visual acuity and intraocular pressure. Functional vision and psychosocial concerns produce a hybrid score that would not make sense because a condition or treatment may affect one component and not the other. They must be scored separately.

The next step was using Rasch analysis, a mathematical model to convert non-linear questionnaire scores into a linear measure, which weights each question appropriately.

Working with children in preceding pilot studies, the teams found that they responded better to questions when given choices related to frequency rather than to difficulty or severity. The PedEyeQ questionnaire was designed with the choices of “never,” “sometimes,” or “all of the time.”

The process of factor analysis and Rasch analysis led to establishing several domains: functional vision; bothered by eyes and vision; social; frustration/worry; eye care (proxy), and treatment. Using the example of the scores of one child with esotropia and the proxy score from the parent’s perception of the child, Dr. Holmes observed that the numbers were substantially different.

‘This is an important clue that we are going to get different answers from how the parent thinks that the eye condition is affecting their child than from how the child responds.’

- Dr Jonathan M. Holmes

In most categories, the child’s score was in the middle of the 0 to 100 range (where 0 is worst and 100 is best), but the parent’s proxy scores were at or near the top of the scale. The parent apparently hadn’t perceived that the child was bothered by vision problems. The child’s score for this “bothered by eyes and vision” domain was 55, and the parent’s proxy score was 100.

“This is an important clue that we are going to get different answers from how the parent thinks that the eye condition is affecting their child than from how the child responds,” Dr. Holmes said.

Future development

The development of this questionnaire is ongoing. It is being administered to additional cohorts of children and parents and undergoing validation to evaluate sensitivity to the severity of conditions, responsiveness to treatment, and test-retest reliability. It is also being compared with the generic PedsQL questionnaire (Pediatric Quality of Life Inventory), which is focused on quality of life.


DR JONATHAN M. HOLMES, MD
e: holmes.jonathan@mayo.edu
This article was adapted from Dr. Holmes’ presentation at the meeting of the American Academy of Ophthalmology. The investigators have grant funding from the National Institutes of Health for this study.
The phase 2 FILLY study met its primary endpoint of statistically significant reduction in geographic atrophy (GA) lesion growth in eyes treated with the investigational complement factor 3 inhibitor, APL-2 (Apellis Pharmaceuticals), compared to sham.

Additional findings from a post-hoc analysis showed that over the 12-month study, the treatment benefit of APL-2 injections given monthly or every other month was maintained irrespective of the presence of select risk factors for GA progression, according to Eleonora Lad, MD, PhD, associate professor of ophthalmology, Duke University, Durham, NC.

Dr Lad, a principal investigator for the phase II FILLY study at the Duke Eye Center, and lead investigator of the phase III Apellis OAKS study, pointed out that APL-2 administration resulted in a significant decrease in GA progression regardless of gender, age subgroups, and baseline lesion sizes.

The FILLY study randomly selected 246 patients 2:2:1:1 to undergo single-masked intravitreal treatment for 12 months, with APL-2 every month or every other month or sham every month or every other month.

Patients were eligible for participation if they had BCVA ≥20/320 and a diagnosis of GA of the macular secondary to AMD with total GA area ≥2.5 and ≤17.5 mm² and at least one focal lesion ≥1.25 mm² if the GA was multifocal.

The analyses presented by Dr Lad evaluated the impact of select baseline characteristics on progression of GA at month 12 in the FILLY study. Variables examined as potential predictors of GA progression included clinical and functional features that have been well-described as prognostic factors in the literature—lesion size, multifocality, location, low luminance deficit, and presence of reticular pseudodrusen—as well as patient demographics.

The data showed that, in general, benefit of APL-2 over sham was observed regardless of patient age, gender, baseline GA characteristics, baseline BCVA, and baseline low-luminance deficit.

Multivariable analyses identified two key risk factors for GA progression: 1) baseline GA lesion location and 2) baseline low-luminance deficit. Treatment effect with APL-2 remained statistically significant when the population was controlled for these two key risk factors.

“These results are in agreement with the prior literature on risk factors for GA progression,” said Dr Lad, who also is director of grading, DukeReading Center. “This is an important finding, as it conclusively demonstrates that the FILLY study population was a typical GA population.”

In addition, the fact that APL-2 was beneficial in reducing GA growth, after controlling for the key risk factors for GA progression in the multivariable analysis, further reinforces the positive results from the FILLY study.

“Note that baseline BCVA dropped out as a prognostic variable, which illustrates the power of doing a multivariable analysis,” Dr Lad explained.

Dr Lad also commented on the strengths and limitations of the research she presented.

“The strengths are that the data come from a relatively large, prospective phase II study, in which GA progression was evaluated by an independent reading center in a masked fashion and in which visual acuity was measured by masked examiners,” she said. “Its limitations include the fact that it is a post-hoc analysis and there were small sample sizes in the subgroups.”

Dr Lad noted that because of the positive results in FILLY, two phase III studies are now under way evaluating APL-2 as a treatment for GA associated with AMD.

**In Short**

The results of the phase II FILLY study are in agreement with the prior literature on risk factors for GA progression.

Dr Eleonora Lad, MD, PhD
E: nora.lad@duke.edu
Dr Lad has no significant financial interests to disclose.
Let Us Be Your Eyes and Ears

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Physician offers pearls for upper eyelid blepharoplasty procedure

After surgery, UEB can improve patients’ visual fields by more than 25%

By Lynda Charters; Reviewed by Dr José Luis Tovilla-Canales

Upper eyelid blepharoplasty (UEB) is the most frequently performed invasive facial esthetic procedure, according to José Luis Tovilla-Canales, MD. The procedure can remove excess skin, muscle and sometimes fat from the upper or lower eyelids. It is performed for either functional or cosmetic indications.

UEB may be performed in a traditional fashion, using stainless steel instruments, or may be modified with radiosurgery incisional techniques or laser incisional techniques.

Following UEB, the visual fields can improve by as much as 26.2%.

Dr Tovilla-Canales, director, Orbit and Oculoplastics Department, Instituto de Oftalmología, Mexico City, Mexico, enumerated his pearls for performing a successful UEB.

“The surgery is usually considered a simple procedure, but there are key points that must be adhered to before surgery to avoid adverse events,” he said.

Dr Tovilla-Canales offered several key points for physicians to consider for successful UEB procedures:

> The procedure is not a recipe. Each patient will have different anatomic landmarks, and, therefore, have different surgical needs.

> The brows and the different amounts of skin to be excised must be considered.

> Understand the anatomy. Knowledge of the anatomy is essential to perform an appropriate technique for each patient.

> The preoperative assessment is one of the most important steps before surgery is even undertaken. The physician must obtain a history and perform a complete examination, discuss expectations with the patient, select the appropriate technique, and discuss potential complications.

> Patients must be instructed to stop taking aspirin and anticoagulants before surgery.

> Physicians also should obtain preoperative photographs in the event that patients question the postoperative outcome. Another consideration in the preoperative assessment is determining whether just skin or skin and fat are to be removed.

“Watch the eyebrow,” Dr Tovilla-Canales said, pointing out that the eyebrows are always considerations when performing UEB.

Dr Tovilla-Canales demonstrated cases with the preoperative presence of upper lid ptosis, a droopy eyebrow, fat pads in the lateral aspect upper lids disguised as upper lid ptosis, and bulging of the upper lids caused by supraobicularis fat, indicating that these must be addressed to achieve an appropriate UEB.

Perhaps the most important surgical factor is marking the incisions, according to Dr Tovilla-Canales.

“With the patient supine, I create the crease in the patient’s natural crease, usually 10 mm from the lid margin in women and a little lower in men,” he explained, demonstrating the pinch test, performed using forceps with the patient sitting and with eyes closed, to determine the amount of skin to remove.

Dr Tovilla-Canales said he uses a guideline of 20 mm from below the incision to above the incision as a safe amount.

When it comes to anesthesia, Dr Tovilla-Canales advises administering intravenous sedation preoperatively and a small amount of local anesthesia.

IN SHORT

> Upper eyelid blepharoplasty is the most frequently performed invasive facial esthetic procedure. It can remove excess skin, muscle and sometimes fat from the upper or lower eyelids, and is performed for either functional or cosmetic purposes.
The incision, skin and fat removal also are important, and Dr Tovilla-Canales said his preference is to create incisions using a blade rather than a CO2 laser because of the possibility of wound dehiscence related to the laser.

Once the incision is created, Dr. Tovilla-Canales performs electrocautery. When removing the orbicularis, he said he prefers to remove only skin and preserve as much orbicularis as possible.

When removing fat, Dr Tovilla-Canales said he extracts the least amount possible to avoid hollowing of the eye. Typically, he removes only the medial fat pad.

Dr Tovilla-Canales also emphasised the importance of identifying lacrimal gland prolapse, which also can mimic the appearance of fat pads. He explained that his procedure of choice in such cases is to reposition the lacrimal gland with sutures.

The procedure is not simply one of removing skin and/or fat, but recognition of structural issues such as ptosis.

“Surgeons must be very conservative with the amount of skin, fat, and orbicularis muscle that is left postoperatively,” he said.

During wound closure and crease formation, the wounds can be closed with interrupted 6-0 or 7-0 nylon or Prolene sutures. In some cases, a crease may need to be created.

Dr Tovilla-Canales also pointed out that he takes a small bite of the orbicularis muscles, a bite of the aponeurosis where it joins the tarsus and finally another bite of the orbicularis muscle in the upper incision.

While UEB appears to be a simple procedure, complications can occur, as is the case with any surgical procedure.

This can include asymmetry, ptosis, lagophthalmos, ocular motility disorders, scarring, hematoma, retrobulbar hemorrhage, and lymphedema.

“UEB is usually a safe and effective procedure,” Dr Tovilla-Canales concluded. “Complications can be prevented by performing an adequate preoperative assessment, understanding the patient’s expectations, obtaining meticulous measurements for skin markings, and proper surgical technique.”
I am a second-generation Armenian. In 1992, when Armenia took the responsibility as the main guarantor of security for Artsakh in her conflict with Azerbaijan, the Armenian government put out a call to all Armenian-American physicians to help treat casualties of war. For me, this was a reminder of the promise I had made to my grandfather at age 12 to return to the homeland when the need arose.

I had never been in a war zone before, and what I saw was shocking. Among the worst injuries were those from landmines and other explosives placed in playgrounds and schoolyards by Azerbaijani military who had overrun the country. I visited hospitals full of soldiers who were bilaterally blind due to severe injuries to their eyes, many of which had become infected.

I did what I could through surgery and the dwindling amounts of medicines I brought. But as I left, I vowed to continue to return. I started visiting Armenia twice a year, often bringing with me desperately needed equipment and medicines, as well as ophthalmologists with different specialisations who could in turn train doctors in Armenia.

The problem of diabetic retinopathy
Despite the horrors that I saw on those early trips, once the guns were silent it became clear that one of the biggest threats to eye health in this country was something with which ophthalmologists worldwide are very familiar: diabetic retinopathy (DR).

Most people with diabetes have no symptoms until their vision is irreversibly damaged. While annual ophthalmic screening is recommended for all people with diabetes, less than half get screened yearly, even in the developed world.

Rates of diabetes and DR are similar in Armenia and the United States, but the impact on vision is more severe because those living in rural areas lack access to routine ophthalmic care. Many of these patients are seen only after they have retinal blood vessels leaking and bleeding within the eye. Without very rapid treatment, a burst blood vessel will destroy vision.

Reaching rural patients
In a country of 3 million, 2 million are poor and live in rural regions, often too poor to travel to the capital for free treatment. To get to them, the idea of a mobile eye hospital was conceived and executed with tremendous support of the Armenian diaspora. This 18-wheeled truck is equipped with two exam rooms, two different lasers, and a fully functional operating room with surgical microscopes and all the instruments needed to perform cataract, glaucoma and retinal surgeries, even corneal transplantation.

This mobile eye hospital has been around the country seven times so far and treated more than half a million people. Our humanitarian organisation has also built four regional eye centres so that people who cannot wait for the mobile eye hospital to arrive in...
their area—which can take up to 2 years—can also receive timely treatment.

**Managing DR**
We have found that the best option for treating DR in patients living in rural areas is laser treatment. One round of therapy is usually enough to stop blood vessel leakage. The typical follow-up for lasered patients comes 6 months after the initial treatment, with touch-ups as required. This is a great way to prevent vision loss over the long term.

One of the most useful tools we have for the management of DR in Armenia has been artificial intelligence (AI) technology (EyeArt AI Eye Screening System, which was donated to us by Eyenuk). It enables DR screening even with limited eyecare resources. This system is a cloud-based screening software that uses AI to autonomously detect DR by identifying the presence, size, position, and number of lesions within each eye.

The system provides fully automated DR screening, including imaging, grading and reporting in a single visit, without the need for eye dilation. Less than a minute after photographing the retina, we get a report, which is used to determine whether the patient needs to be treated right away or seen again in 3, 6, or 12 months. Those who require immediate treatment are sent to one of the four regional eye centres or the mobile eye hospital where laser treatment is available.

At publication, 8,147 patients have been screened in Armenia using the system. The AI eye screening system found 2,917 cases with referable diabetic retinopathy or macular edema. Those with vision-threatening DR or macular edema have been referred for additional treatment.

A higher prevalence of vision-threatening disease is expected in a country like Armenia where there is a large population of diabetic patients who do not have access to an ophthalmologist. That is why the Eyecare Project is so important—until now, there has been no systematic DR screening program available.

We all have something to offer the less fortunate, our own particular set of skills or knowledge base. My skills as an ophthalmologist can go exponentially further when I have the most advanced tools and equipment available to me.

Partnering with Eyenuk has allowed us to help numerous people keep their sight, and we will continue to screen and treat as many patients as possible.

Our Armenian colleagues continue to screen patients throughout the year, not just when the Armenian Eyecare Project is in town. They are committed to eliminating preventable blindness in Armenia and teach that principle. In yearly conferences, they will teach that goal to neighboring countries and pass along what they have learned. This has been a good example of medical diplomacy, and it is working.

**ROGER V. OHANESIAN, MD, FACS**
E: rogerohanesian@gmail.com
Based in Laguna Beach, CA, Dr. Ohanesian founded the Armenian EyeCare Project in 1994 as an initiative to eliminate preventable blindness in the country.
Alimera launches ILUVIEN in Germany for non-infectious uveitis indication

Alimera Sciences Inc. announced that it will immediately commence the launch of ILUVIEN in Germany for the prevention of relapse in recurrent non-infectious uveitis affecting the posterior segment of the eye (NIPU).

Following the European Union’s Mutual Recognition Procedure in March 2019, Germany is the second country in Europe in which the product is now commercially available to be prescribed to patients suffering from NIPU. In June 2019, Alimera announced a positive recommendation by the National Institute for Health and Care Excellence (NICE), facilitating launch of the NIPU indication in the United Kingdom.

“The launch in Germany represents our second country rollout for ILUVIEN’s expanded European indication for uveitis, a retinal disease that anti-VEGF drugs do not treat,” said Rick Eiswirth, president and CEO of Alimera Sciences. “We continue to receive encouraging feedback from physicians regarding ILUVIEN’s unique continuous microdosing technology, with its ability to reduce the recurrence of disease in patients diagnosed with either non-infectious posterior uveitis or DME.”

For more information, go to www.alimerasciences.com

Aerie submits PAS to FDA to allow Rocklatan production in Ireland

Aerie Pharmaceuticals announced the submission of a prior approval supplement (PAS) to the FDA. If approved, the PAS will permit production of Rocklatan (netarsudil and latanoprost ophthalmic solution) 0.02%/0.005% for sale in the United States in Aerie’s new manufacturing plant in Athlone, Ireland.

“Along with the successful GMP inspection and authorisation of the Athlone plant for product manufacturing by Ireland’s Health Products Regulatory Authority (HPRA), we have also successfully executed process validation studies for Rocklatan and generated stability data to support registration of the Athlone plant with the FDA,” said Vicente Anido Jr., PhD, chairman and CEO. “Our PAS submission is another milestone ... as we continue to move toward having our state-of-the-art plant facilitate the global supply of Aerie products.”

Aerie expects the PAS filing review to be completed within 60 days, with final PAS review in 4 months. In addition, the company anticipates a preapproval inspection of the Athlone manufacturing plant during the 4-month review. A successful inspection along with FDA approval of the supplement would allow Rocklatan to be manufactured in Athlone for sale in the United States in the first half of 2020.

For more information, go to www.aeriepharma.com

Myopia management newly defined with Oculus device

The Myopia Master device from Oculus combines all the important measurement methods of myopia management: axial length, refraction values, and the central corneal radii, according to the company.

Axial length measurement today is regarded by experts as the gold standard for myopia management and a must for every myopia expert. This quick, contactless and accurate measurement method is not influenced by the accommodation-status of the eye and delivers reproducible results also in children. Axial length is the only parameter with which the progress of myopia can be monitored over time after fitting Ortho-K lenses, said the company in a prepared statement.

The device creates a myopia report for each patient, giving due consideration to such myopia risk factors as having myopic parents, time spent outdoors, or time spent on near-vision activities. In this way the device assists in educating patients, unobtrusively helping them want to return for follow-up visits.

The device can be mounted on a workstation or on an ophthalmic table. The software can be operated either directly via the display or from a connected computer.

In other news from the company, four new software features were introduced for the Oculus Corvis ST at the ESCRS 2019. These updates will further increase the number of clinical applications that can be addressed based on corneal biomechanics. They include the assessment of biomechanical stability after corneal refractive surgery, a biomechanical comparison display that allows monitoring biomechanical changes over time, the quantification of corneal elasticity based on the stress-strain behaviour of corneal tissue, and a glaucoma screening software.

The Corvis ST is a combination of an air pulse tonometer with an ultra-high-speed Scheimpflug camera. Shortly before the air pulse starts the cornea is illuminated by a blue slit light, and corneal thickness is measured simultaneously. The high-speed camera tracks the corneal biomechanical response thus provoked.

For more information, go to www.oculus.de
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