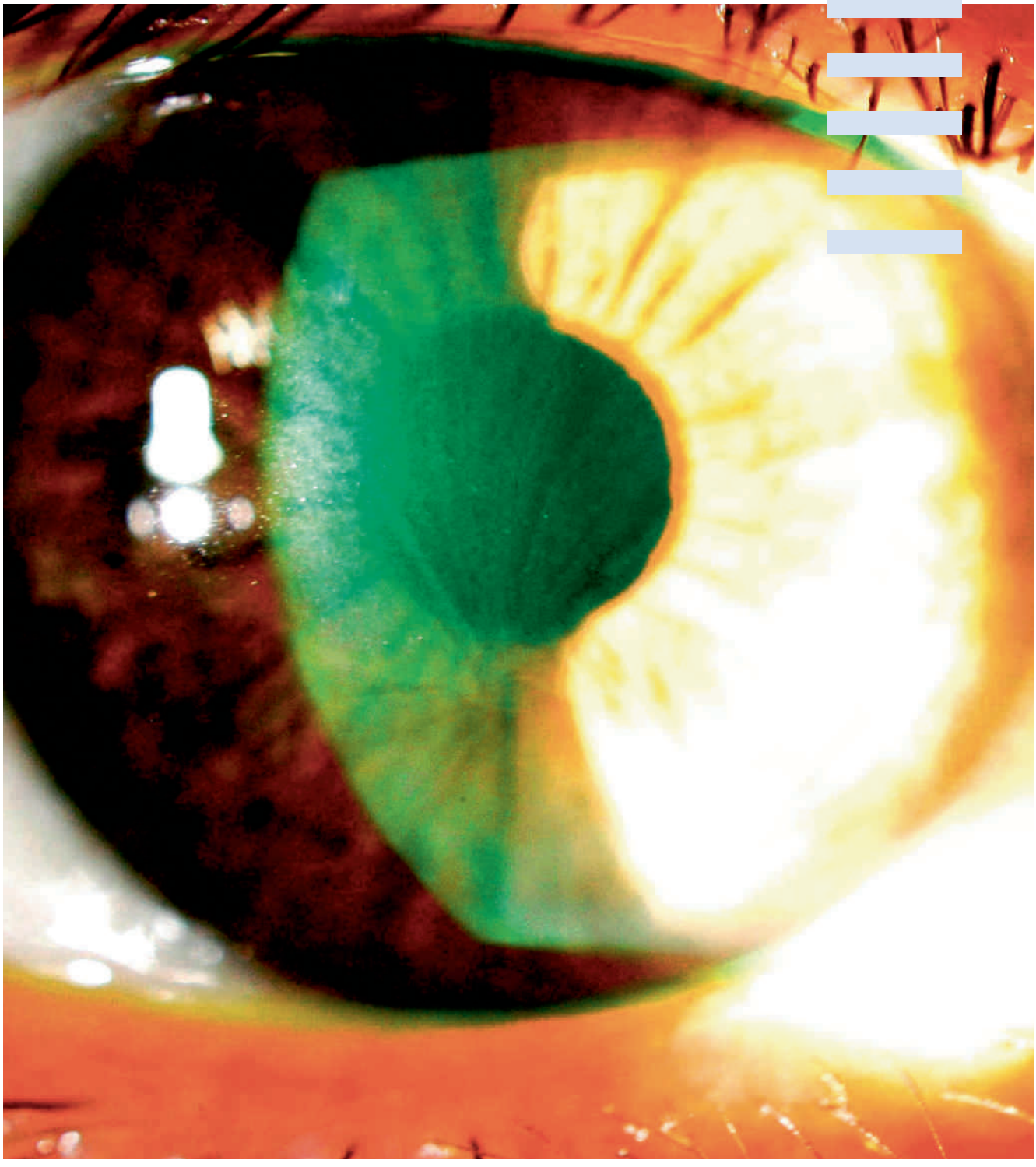
Supplement to
AUSTRALIAN OPTOMETRY

Special issue
METABOLIC EYE DISEASE

pharma

DECEMBER 2012



- Fabry disease and the role of optometrists
- Post-LASIK dry eye
- Fluorescein
- Pterygium
- Side-effects of dronedarone
- Herpes zoster
- Acanthamoeba

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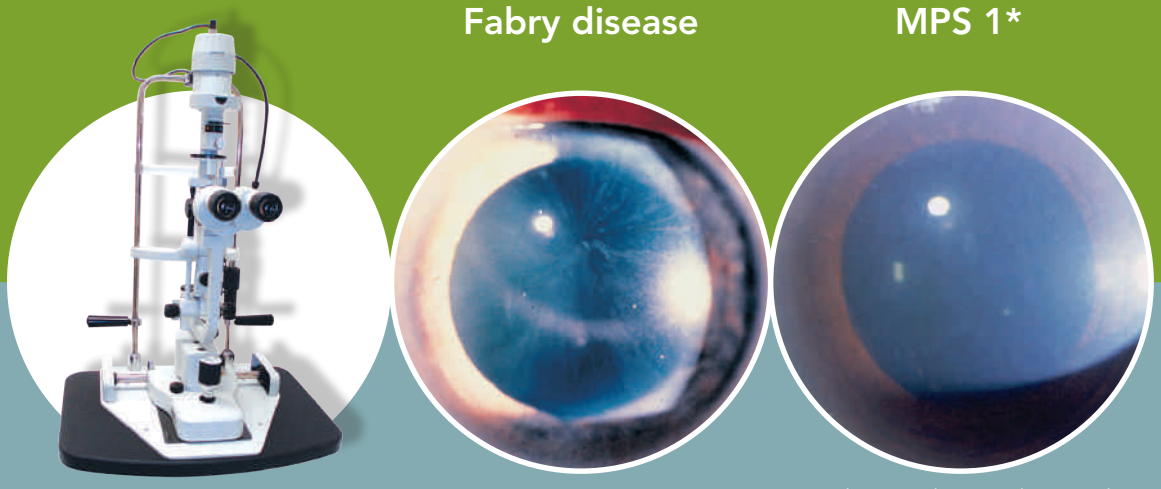

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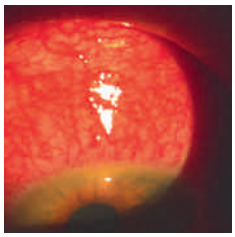
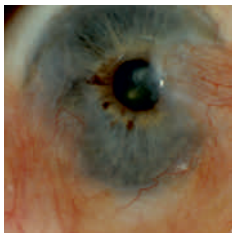
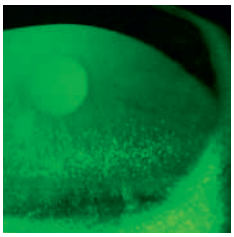
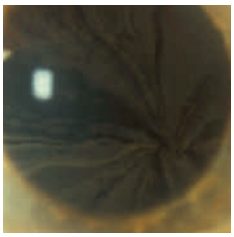
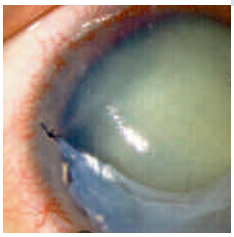

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COVER
Verticillata and corneal haze: note the vortex in the inferior cornea, which is characteristic of Fabry disease
Photo: Associate Professor Langis Michaud OD
École d'optométrie de l'Université de Montréal

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Special issue: METABOLIC EYE DISEASE

Averting and treating post-LASIK dry eye

Professor Gerard Sutton
MBBS MD FRANZCO
Sydney Medical School Foundation
Professor of Corneal and Refractive Surgery

Laser-assisted *in situ* keratomileusis (LASIK) is the most common and most successful of the refractive surgical procedures now available. It involves the creation of a thin, hinged corneal flap, the resculpting of the corneal stroma with an excimer laser and the careful repositioning of the flap. While in theory it can be used to treat myopia up to 10 dioptres, hyperopia up to 5 D and astigmatism up to 6 D, the predictability is better with other surgical procedures for ranges beyond myopia up to 8 D, hyperopia up to 4 D and astigmatism up to 4 D. In my practice, LASIK accounts for over 65 per cent of surgical treatments and the satisfaction rate is reported in the literature at between 95-96 per cent.[1]

The surgery was first performed in 1989 by Dr Ioannis Pallikaris in Greece.[2] Following the original procedure, there have been many significant improvements in the surgical technique, perhaps most significantly, the introduction of the femtosecond laser to create a more precise, reproducible flap. Algorithm changes and a faster, more accurate delivery system with accurate tracking mechanisms have been other important improvements.

While significant complications are extremely rare, even in experienced hands some challenges remain. Retreatment is still required in some cases and the rates vary depending on the initial refractive error treated.[4] The prevention and treatment of dry eye disease (DED) remains an important part of management. In a study by Wilson, around 50 per cent of LASIK patients will report dry eye symptoms.[5] Appropriate attention to this condition often determines a patient's final visual quality and can be the difference between a good result and an excellent outcome.

Preoperative assessment

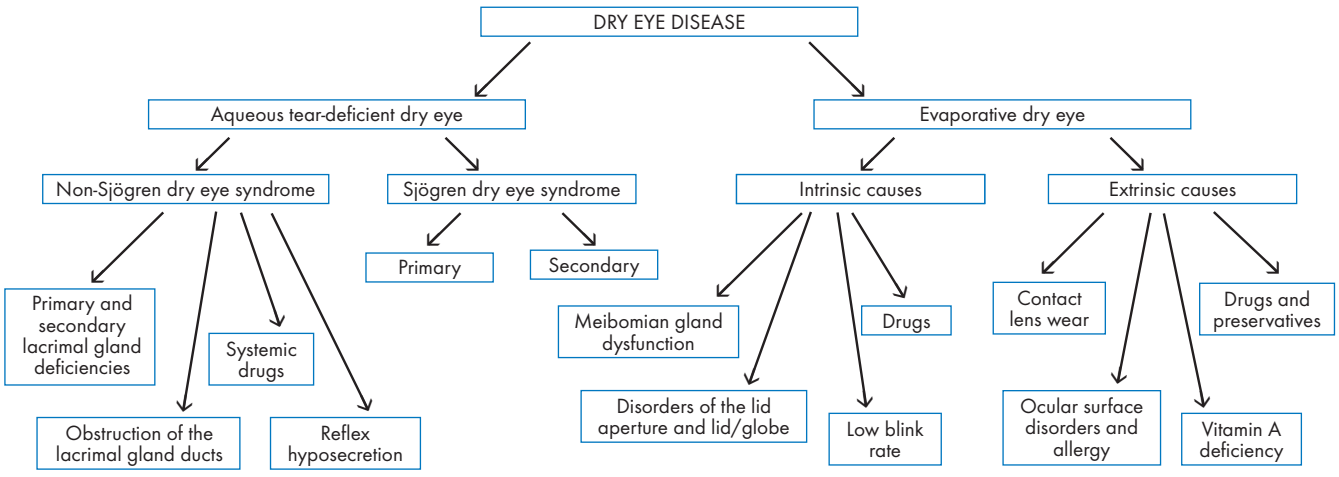
History-taking is critical in identifying patients who might be at risk of developing dry eye. Given the success of contact lenses and recent improvements to extended-wear technologies, it is often the 'failed' contact lens patient who is referred for refractive surgery. Dry eye and ocular surface disease are often contributory to the contact lens failure.

The first question I ask patients who have previously worn contact lenses is why they stopped. Symptoms of dry eye with contact lenses highlight potential dry eye issues following LASIK. I also ask about oral medications as many, including antidepressants, can lead to reduced aqueous secretion. If the patient does describe dry eye symptoms, I will also ask about other sicca symptoms such as dry mouth and even other dry mucous membranes. One useful question is to ask if the patient frequently wakes up in the middle of the night to have a glass of water. If patients have dry-eye symptoms, I always ask about systemic disease such as systemic lupus erythematosis.

Often people labelled as having dry eye have allergic eye disease. 'Itch' usually indicates allergy and a history of atopy may indicate an inflammatory contribution to the patient's ocular surface disease.

I think the International Dry Eye Workshop classification of dry eye syndrome into aqueous deficiency problems and evaporative issues is useful (below). I will often ask patients if they are capable of crying. Essentially if they can cry, they can produce tears. Those who state that they can never cry may have significant aqueous tear deficiency and warrant a medical work-up and serological investigations for Sjögren's disease.

I commence my examination by sitting back and looking at the patient. I note the



International Dry Eye Workshop classification of dry eye syndrome

lid position and am making a mental note of the size of the palpebral fissure and orbital rim. A large palpebral fissure or inferior scleral exposure increases the risk of evaporative tear loss. On the slitlamp, I look closely for blepharitis and meibomian gland dysfunction (MGD). MGD is often under-diagnosed and therefore under-treated. I believe the ophthalmic community has underestimated the importance of MGD in dry eye disease. I look at the gland orifices for any notching that might indicate gland drop-out. If concerned, I will compress a gland to ensure that a clearish fluid can be expressed rather than a toothpaste-like or even absent excretion. I note the anatomy of the glands and whether there is any tarsal conjunctival inflammation.

I note the blink rate and the excursion of the upper lid. Lagophthalmos is also under-diagnosed and if the lids do not spread the tear film through the lower half of the cornea, dry eye symptoms will ensue. The upper lid must always be everted to exclude giant papillary conjunctivitis, concretions and tarsal inflammation.

I rarely use a Schirmer's test these days due to its reported lack of sensitivity and specificity. If I am suspicious of a severe aqueous deficiency, I will use it to confirm my suspicions. More commonly, I will apply the fluorescein dry strip to the tear meniscus and observe its wettability. The most important dry eye investigation is tear break up time. It is semi-qualitative but certainly the most reliable in identifying patients who will either need treatment or be excluded from corneal refractive surgery.

If there is any evidence of punctate staining, the patient is not suitable for surgery. It reflects 'sick' epithelial cells and until the underlying condition that has caused the staining is resolved, surgery should not proceed.

Finally, I warn all patients that everybody, including myself, will have some dry eye symptoms after LASIK or PRK. For most, these symptoms last two to three weeks but for some it can be more problematic.

Preventative treatment

Preoperative treatment is directed at the underlying mechanism. I will use topical steroids in all patients who have inflammatory signs whether they are related to MGD or allergic conjunctivitis. Often this will simply be Fluorometholone (FML) TDS for one week prior to the surgery. Inflammation is often overlooked as a significant component of the dry eye picture. It should be treated before the surgeon induces more inflammation with the laser.

Aggressive treatment of blepharitis with commercial lid scrubs are common practice and easy for the patient. When I indicate to patients that their success in clearing the blepharitis will determine their ability to proceed to surgery, motivation is no longer a problem. Any *Staphylococcal* lid disease needs to be treated with topical antibiotics with chloramphenicol or fusidic acid effective. Any active potential infective lid disease is a contra-indication to surgery and must be resolved prior to surgery. Infection following LASIK is very rare.[6] To now, I have not had a post-LASIK infection and I have been performing this surgery since 1995.

Preservative-free topical lubricants are also obviously important but if the patients are regularly requiring drops more than three times a day despite treatment of the underlying disorder, a corneal refractive procedure is probably not a good idea.

Newer eye formulations such as Systane Ultra (Alcon) may make a greater contribution to the mucin layer and therefore be more effective in MGD evaporative disease. In patients with significant MGD, I will always try a course of oral doxycline or minocycline, which I find to be better tolerated and easier to prescribe. My recommended dosage is 100 mg per day for a minimum course of three months.

I am a convert to the use of Omega-3 supplements for dry eye, thanks mainly to my partner and friend Associate Professor Colin Chan. Fish oil is better tolerated in most cases than flaxseed-oil, and while a combination may prove the most efficacious, I find patients will get some benefit from fish oil alone.

Surgery

LASIK induces a dry eye effect by disturbing the neural reflex from the corneal surface that is important in both basal and reflex tear production.[7] Corneal sensitivity takes six to nine months to return to normal.[8] For this reason, LASIK remains a poor option for patients with moderate to severe dry eye, despite adequate treatment. In these cases, an intraoperative procedure, such as a refractive lens exchange or phakic IOL, would be preferred. Most patients can proceed to surgery, understanding that for at least a few weeks they will be using supplementary lubricants.

There is good evidence that the introduction of the femtosecond laser for the creation of the cap has reduced dry eye problems.[9] I performed the first femtosecond laser in Australia in 2004 and have not used a metallic blade since. The femtosecond is more predictable in flap construction and smaller, and thinner flaps causing less nerve trauma can be created reproducibly when appropriate. It also avoids the shearing forces of a microkeratome.

In peri-menopausal women and people who have any level of aqueous deficiency, I insert dissolving punctual plugs at the time of surgery. This is a very effective preventative measure.

Postoperative routine treatment

Postoperatively, my patients receive topical ciprofloxacin and dexamethasone qid for one week. A further course of FML 0.1% is then used for a further two weeks. Patients are encouraged to use topical lubricants at least three times a day for the first two to three weeks or longer as necessary. I review all my patients personally postoperatively.

Postoperative dry eye

In the vast majority of cases, significant dry-eye issues can be avoided if the above steps are taken but in some cases, more treatment is required. Again my approach is based on treating the underlying cause.

My stepwise approach is:

1. Use preservative-free topical lubricants. I prefer Bion tears, Systane, TheraTears and Cellufresh, but often the patient will work out his or her preference.
2. If there is any persistent inflammation, I will add topical prednisolone minims (preservative-free). The usual dosage is tds for three weeks.
3. If I have not previously inserted dissolving punctual plugs, I will do so unless there is significant inflammation, in which case plugs can exacerbate the symptoms.

In most cases this regimen and time will resolve the problem. Rarely Cyclosporine A 0.05% or stronger steroids are necessary. I have never had to use autologous serum in LASIK patients and to date have never had a patient with permanent dry eye as a result of LASIK surgery.

Conclusion

LASIK is a safe and effective surgical procedure. Problems with dry eye after LASIK can be avoided, if attention to the ocular surface and tear film is meticulous preoperatively. ■

References are available from j.megahan@optometrists.asn.au, subject:post-LASIK dry eye, Pharma December 2012.

Poor compliance with hand hygiene contact lens patient drop-out rate

Washing your hands and keeping them clean during a consultation cannot be treated lightly.

Charles McMonnies
Adjunct Professor, School of Optometry and Vision Science UNSW

Optometrists' awareness of the need to maintain high clinical standards of hand hygiene is possibly at an all-time high. Since the introduction of therapeutic qualifications, this topic is receiving an unprecedented amount of attention during undergraduate and graduate level studies. As the email (right) indicates, lapses can still occur.

Maybe the practitioner discussed had washed his or her hands toward the end of the previous consultation, prior to inviting the author of the email into the consulting room. Hygiene performed out of the patient's view can lead them to assume that it has been neglected. Seeing is believing. It is also possible that the events described in the email involved a significant lapse in what should be a standard hand-washing procedure.

What is 'standard hand-washing procedure'? One sample of health-care workers was observed to take only an average of five seconds to wash their hands between patients.[1] In another study, those in a post-anaesthesia care unit asked to explain why they did not wash repeatedly offered these responses: 'I don't have time', 'I do not need to wash my hands' and 'It is too inconvenient'.[2]

Poor hand hygiene was found to be a common risk factor for hospital-acquired keratoconjunctivitis.[3] Health-care workers were found to have an average of 3.9 x 104 to 4.6 x 106 aerobic bacteria colony-forming units on their hands.[2] In addition to bacterial infections, epidemic keratoconjunctivitis is very easily transmitted both from and to patients, and hand-washing is a key aspect of management.[4]

The problem is not necessarily just a lack of any hand washing or even too short a procedure, but also poor hand washing technique. Of a group of practitioners who rated their hand washing technique as 'excellent' prior to evaluation, only 20 per cent gave themselves that rating after objective evaluation—even though they were aware it was being performed.[5]

Teaching hand hygiene to contact lens patients

A review of studies of contact lens patient compliance with hand hygiene over 25 years to 2011 found that it had been consistently poor.[6] A previous examination of how to improve contact lens patient compliance[7] emphasised how successful patient behaviour modification depends on explaining why they should improve their hand washing technique as well as explaining how. Not appreciating why provides a foundation for neglect that is compounded by not knowing how. Infections and other contact lens wear problems resulting from poor hand hygiene show that failure to teach effective hand hygiene is another way to lose a patient.

Average learning retention rates for different kinds of teaching vary from about five per cent for a lecture, 10 per cent for reading once, 20 per cent for a demonstration, 30 per cent for a discussion group, 75 per cent for practise by doing, and 90 per cent for teaching others.[8] Even when a full explanation and demonstration have been provided, within minutes of a consultation, the patients forget as much as 50 per cent of the advice provided.[9]

Contact lens patients retain greater knowledge of what to do if they are advised to go home and teach their family how and why to wash their hands effectively. Optometrists could be expected to similarly benefit in maintaining higher standards of hand hygiene by being more involved in teaching patients how it should be done.[10]

Practitioners washing their hands in front of contact lens patients have ideal opportunities to reinforce previous instructions or correct poor memories of previous instructions, and to reassure patients that high personal standards are routine. As indicated in the email, patients judge the adequacy of the standard of hygiene demonstrated by the practitioner.

Make your point

Every opportunity patients have to observe a practitioner's hand washing technique is an opportunity for making a point. Sample comments include:

- Rinsing with running water is a good start because it removes some superficial dirt, but it removes very few germs. Importantly, rinsing makes it easier to work up an effective soap lather.
- A complete coverage with soap lather is essential for loosening germs from the skin but working the lather into the skin is needed to improve the germ removal process. The loosened germs end up in the lather but will remain on the hands unless rinsed off thoroughly.
- Rinsing thoroughly needs to be combined with rubbing to remove all the soap lather and all the loosened germs in the soap lather. Thorough rinsing leaves the skin squeaky clean. All the soapy slipperiness and germs must be rinsed off.
- Hot air driers and reusable towels put germs back onto the skin. Hot air driers contaminate hands with aerobic bacteria; millions of them easily stick to wet hands, negating the hand washing effort completely. Safe drying is achieved with a single-use paper or cloth towel. Fortunately, there are professional-looking boxed paper towels available as well as a variety of wall-mounted dispensers that save desk-top space. At home, kitchen paper is excellent for this purpose.
- Drying is very important. Major eye infection can occur due to germs (*Acanthamoeba*) found in tap water, so drying effectively is necessary.

Taps are always contaminated because

increases

they are always turned on by dirty hands. The used paper towel is perfect for turning taps off as well as opening doors when leaving a bathroom or toilet.

Email Charles McMonnies at c.mcmonnies@unsw.edu.au for Miscrosoft Word files on hand washing. The files are designed to be printed on your personal practice letterhead. The information will not be as effective when delivered only as a single hand-out to patients.

Offering your patients too much information all at once can dilute the absorption of the different messages. Apart from using it as a hand-out in your practice, single items or groups of items from the hand-out can be delivered through a series of newsletters and emails or on your practice website. Any of the other points mentioned in the hand-outs can be raised in the consulting room when the practitioner provides a demonstration of how hand hygiene should be practised.

For contact lens patients who have rarely washed their hands prior to handling their contact lenses, a lottery analogy helps to modify their behaviour. Analogy details are also available from c.mcmonnies@unsw.edu.au. ■

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Patient's email to Charles McMonnies

From: Helen
To: Charles McMonnies
Subject:

Is changing of disposable soft lenses for sight-impaired patients in the repertoire of procedures for optometrists?

Hello Professor McMonnies,

My optometrist is performing the above procedure for me each month but his hand-washing technique before removing the old lenses has deteriorated to the point where he is using no liquid soap, just a quick rinse of the hands in cold tap water, rapid paper towelling, usually followed by absent-mindedly touching his necktie and tapping the thigh of his trousers with his dominant hand, before sticking the index finger of that hand, with considerable pressure, straight into my eye.

I have had a long-dead corneal graft on that eye, maintained by a 30-day disposable corneal bandage, Chlorsig and Maxidex drops twice daily, and careful eyelid cleaning. The eye's visual acuity is hand movement only. The other eye is tenuously sighted after multiple eye surgery on it. I have difficulty seeing to change the corneal bandage myself.

Each disposable lens costs $27.66 and the fee to change it is $34.90.

I tactfully raised the perfunctory hand washing with my optometrist when he changed my lens yesterday. He was embarrassed, embarrassing me because I don't know whether what I am asking him to do is part of his clinical training, and whether he is aware of the importance of washing his hands properly and has been trained in how to do so. I guided him initially in how to go about changing my lens. His drop-off in hand washing is a fairly recent thing. Maybe he is trying to tell me something.

I found your name and web address in a short article in which your free compliance summaries were offered to optometrists for their patients. It was in the *Contact Lenses* supplement to *Australian Optometry*, October 2011. This was on the Optometrists Association's website. I am a busy, well, interested, self-funded retiree with no relatives. I live sea-side in (suburb supplied). At this stage of life, the interests of my acquaintances have narrowed to their grandchildren and their own ill health. I impose myself upon them as little as possible.

I therefore hope I can rely on competent skills in my local health professionals to avoid the now tiring train trip to Sydney for a lens change. I did have a visiting eye surgeon changing my lens for a short time in (suburb supplied). He was no better at hand-washing and used to do his keyboarding after washing his hands, then put his newly-dirtied finger in my eye.

I maintain a sense of humour and am grateful that so far, I haven't had a *Staph* or *Pseudomonus* infection. In summary, are optometrists trained, willing and able to change soft, disposable corneal lenses for sight-impaired patienst, and are they trained to routinely, thoroughly, wash their hands between patients for their patients' safety and good eye health?

With best regards
Helen (surname supplied)

Femtosecond surgery update

Dr Michael Lawless
MBBS FRANZCO FRACS
FRCOphth
Vision Eye Institute

In April 2011, femtosecond laser cataract surgery was introduced to Australia when I performed the first surgery at the Vision Eye Institute in Chatswood, NSW. The introduction of this technology created much interest domestically and internationally.

Proponents suggest the use of lasers to perform several steps of the cataract procedure will lead to greater safety and visual outcomes, thereby benefitting patients. Those against taking up the technology have cited existing excellent outcomes and economic concerns.

The ability of the laser to produce more consistent, circular capsulotomies and accurate corneal incisions, and reduce the required energy for phacoemulsification compared to manual surgery, is undeniable and can be cited in the literature. The impact of these improvements on the safety and clinical results is yet to be fully elucidated. With over 40 articles published in the peer-reviewed literature by late 2012, there is a growing body of evidence. The following is a review of the recent literature, including the results obtained at the Vision Eye Institute, in an attempt to give the wider eye-care community a sense of the contribution of this technology.

Learning curve

Earlier this year, my colleagues and I published the safety results of our initial 200 laser cataract procedures.[1] This illustrated, for some, a significant learning curve and although the overall incidence of complications remained low, it increased compared to the recent experience with standard surgery, particularly in terms of anterior and posterior capsular tears and posterior capsule rupture.

Although we suggested that the learning curve in conjunction with rapidly evolving software and hardware improvements is relatively short, the publication of our results provided fuel for advocates against the uptake of the technology. Since the publication, we have assessed the subsequent 1,300 cases, comparing these results to the original data and further to available rates in the peer-reviewed literature for manual cataract surgery. There was a significant improvement on all measures between the initial group and the consecutive cases. 0.3 per cent incidence of anterior and posterior capsule tear (0.6 per cent combined) and 0 per cent posterior lens dislocation are equal to or surpass the established optimal rates for manual surgery, which suggest ranges of 0.8 per cent to 5.3 per cent[2,3] for anterior tears, and 0.5 per cent to 2.7 per cent[4,5] for posterior tears.

Recently, Nagy and colleagues[6] suggested that macular oedema, as measured by optical coherence tomography (OCT), was significantly less following laser cataract surgery compared to a manual cohort. With these results, we are potentially seeing the true indication of safety for this technology. However, more time and more significant numbers may be required before these results confirm the putative advantages of the femtosecond laser for all ophthalmologists.

Advantages

Over the past decade, there has been a significant increase in the postoperative refractive demands from cataract patients. Although improved biometry and intraocular lens (IOL) calculation formulas have helped surgeons enhance their results, on average, only 55-65 per cent of patients will achieve a final refraction within 0.5 D of the target.[7] It has been suggested that the main source of refractive error is the position of the IOL following surgery.[8] This is determined by factors such as lens thickness, preoperative refraction, axial length and age. In 2012, Kranitz[9] provided solid evidence that the consistent capsulotomies created by the femtosecond laser produce a functional improvement in terms of horizontal and vertical tilt and both horizontal and total IOL decentration compared to a manual cataract surgery.

Tilt and decentration can increase the internal aberrations reducing the potential optical quality of the eye. In their study, the laser cataract group showed slightly better uncorrected vision than the manual group. However, this was significantly improved with corrected visual acuity, suggesting that the higher level of aberrations caused by decentration and tilt could not be corrected adequately by optical aids in the manual group.

Filkorn and colleagues[10] more recently suggested the advantage of cataract surgery may also manifest in the statistical differences in refractive terms. The mean absolute error of a laser cataract cohort (n = 77) vs the manual cohort (n = 57) was 0.38 ± 0.28 D and 0.50 ± 0.38 D, respectively. The differences were greater in short and long eyes where changes are likely to be amplified. Overall, 69 per cent of patients were within 0.5 D of the intended outcome for the laser group, compared to 65 per cent for the manual group. The effectiveness of this comparison was reduced slightly as the study incorporated several different IOLs.

My colleagues and I selected a consecutive group of patients undergoing laser cataract surgery with a single-focus IOL and compared it to a retrospective, personalised manual group with a similar IOL.[11] We found that 83 per cent of patients obtained a postoperative spherical equivalent within 0.5 D of the intended target for the laser cataract cohort, against 82 per cent for the manual group. These early, non-personalised laser cataract results suggest a consistency matching the optimal results for a manual group of patients.

In a further comparison, we reviewed patients undergoing implantation of multifocal IOL (ReSTOR 3+) and compared these patients to a matched, retrospective cohort. Although there was no difference in the mean absolute error from intended target (0.26 ± 0.25 Ds vs 0.23 ± 0.16 D for laser and manual groups, respectively), there was a significant difference in the number of patients achieving uncorrected visual acuity of 6/7.5 or better (84 per cent versus 66 per cent, respectively). Similar to the monofocal comparison, the laser cataract IOL calculations had not been adjusted for the personal surgeon nomogram. Although the numbers were relatively small, these findings may serve to confirm the assumptions of Kranitz and associates indicating that laser cataract surgery can lead to more stability and less internal aberrations for the patient.

Evolving technology

Laser technology is a significant issue. There remains a reasonable disparity among

surgeons in terms of postoperative complications. Experienced surgeons will suggest their own results remain excellent but we have shown that laser cataract surgery now may represent a further improvement. The increasing uptake of this technology in 2012 suggests this reflects the developing view of surgeons worldwide. The debate over improved refractive results remains open. Skilled surgeons again will attest to excellent refractive outcomes. We provide evidence that laser cataract surgery will provide at least similar results. Potentially, refractive outcomes and optical quality may be further improved for these patients.

The use of concurrent laser-guided arcuate incisions to treat corneal astigmatism may provide further options. Femtosecond technology will continue to evolve and results will be refined but we may not see the final refractive benefit of laser cataract surgery until IOL technology and calculations match these exciting advances.

We believe that femtosecond laser cataract surgery represents a worthwhile advance over conventional cataract surgery. Time and results may confirm our optimism. ■

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Clinical QUIZ

Nancy Ngo
BOptom (Melb)
Gisborne VIC

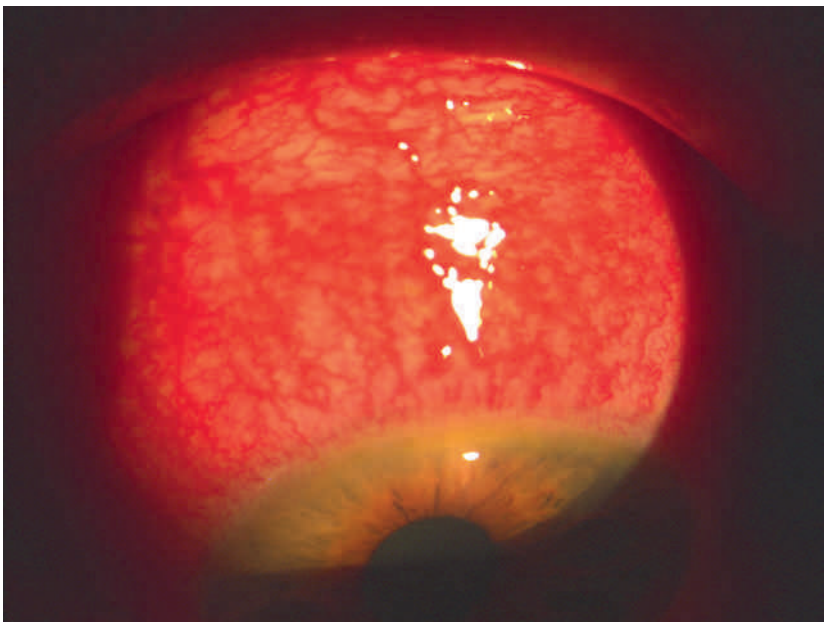

Figure 1. On presentation

Presenting complaint

FP woke five days prior to presentation with a very red left eye. He had been prescribed Chlorsig eye-drops by another practitioner and had been using them four times a day for the previous five days but was not noticing any improvement. He reported no discomfort or discharge and was just concerned with the appearance of his eye.

Ocular and medical history

Medical history was unremarkable; he had suffered a branch retinal vein occlusion in his right eye 18 months before.

Key features of the examination

Unaided visual acuity was measured to be 6/6 R & L. Slitlamp examination revealed grade 3 conjunctival hyperaemia nasally/inferior and temporally, and grade 4 conjunctival hyperaemia superiorly in the left eye.

The blood vessels were dilated and tortuous and chemosis was present, especially superiorly. The cornea was clear and anterior chamber was quiet. Intraocular pressure was 14 mmHg OU.

Dilated fundus examination using 0.5% tropicamide revealed healthy optic nerves and maculae OU. In the right eye, there were some remnant retinal haemorrhages presumed to be secondary to the patient's reported branch retinal vein occlusion. 2.5% phenylephrine was instilled in the left eye and achieved blood vessel blanching.

Differential diagnosis

Episcleritis, scleritis, uveitis, viral conjunctivitis.

What are your diagnosis and management?

ANSWER PAGE 31

Bandage lenses for dry eyes

Case report

Kate Johnson
BAppSc(Optom)Hons
GCOT FBCLA FIACLE
FCCLSA FAAO

Contact lenses are generally considered too challenging to a dry ocular surface but in this case, daily disposable lenses have served as a barrier to the environment as well as a mechanism to trap a reservoir of ocular lubricants against the corneal surface for improved ocular comfort and resolution of clinical signs.

DK is a 42-year-old female who presented with concerns about dry, red eyes and contact lens discomfort. With a spectacle prescription of R -4.75/-4.75x2 (6/4.8-2) and L -5.25/-6.50x6 (6/6+1), she had worn contact lenses full-time for the past 25 years. In the past two years, she had run into problems with epiphora and ongoing irritation, even when wearing her glasses. She could wear her conventional soft toric contact lenses for only six or seven hours a day and described her eyes as 'full-time sore'. DK had a minor history of sinus allergies and hay fever but did not report any medications or previous significant medical history.

Fluorescein evaluation (Figure 1) showed Grade 2-3 inferior superficial punctate keratopathy (SPK) on each cornea as well as diffusely on the conjunctiva in each eye. There was no superior corneal SPK, indicating that exposure was the key influence on the clinical signs. No signs of ocular allergy and mild meibomian gland dysfunction (MGD) were evident. Fluorescein tear break-up time was five seconds for R and L eyes.

It was found that DK's current spectacles were R and L -0.75 over-corrected, so prior to changing her glasses, it was decided to trial wearing bandage lenses – daily disposable Johnson & Johnson Acuvue TruEye 8.5 R and L +0.50 – while wearing her glasses. DK was instructed to abstain from wearing her conventional soft toric lenses until her

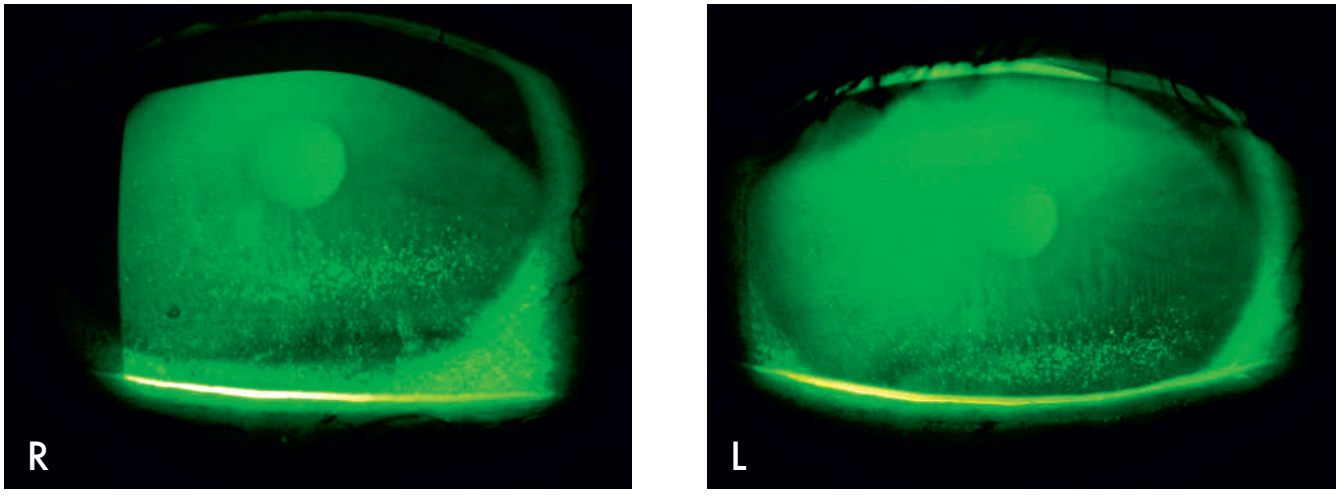

Figure 1. Right and left eyes, respectively, of patient DK, showing bilateral inferior superficial punctate keratopathy at baseline

Daily disposable lenses can provide an environmental barrier for aqueous deficient and evaporative dry eye conditions, while trapping lubricants.

ocular surface improved and CooperVision Proclear XR toric monthly disposable trial lenses were ordered for wear after the following appointment.

It was determined that more frequent replacement of DK's contact lenses would be beneficial to improving contact lens comfort. She was instructed to commence hot compresses and lid massage once daily for her mild MGD and to use TheraTears lubricating drops for comfort, two to four times daily when the lenses were out, on contact lens insertion and as required throughout the day.

On review one month later, DK had sparingly worn her conventional soft toric contact lenses and worn the +0.50 bandage lenses under her glasses close to full time. She reported much improved ocular comfort and the appearance of her corneae was much improved, with the superficial punctate keratopathy almost entirely resolved. DK was keen to return to contact lens wear so she was provided with Proclear XR Toric monthly disposable trials in the power R -4.50/-4.25x180 and L -5.00/-5.25x5. She was instructed to wear the bandages plus glasses option half and half with her contact lenses.

DK has had some issues since with toric lens stability and has been fitted with Synergeyes Duette hybrid contact lenses, which feature a high dK RGP central lens with a silicone hydrogel skirt. The Duette lenses overcome the issue of toric lens stability and provide excellent vision for astigmats, provided their spectacle and ocular astigmatism are in close agreement. In DK's case, she was left with R 0.00/-0.75 x 25 and L 0.00/-0.75x170 residual astigmatism with the Duette lenses. She said she was much more satisfied putting up with this minor blur compared to the variability she had been suffering in her vision with the soft toric lenses.

DK has been wearing her Duette contact lenses about 70 per cent of the time, and her bandage daily disposable lenses plus glasses the remaining time. Figure 2 shows her current fluorescein evaluation, six months after her first presentation. The inferior SPK has not resolved entirely and had appeared better after the initial exclusive period of wearing bandage lenses plus glasses, but considering her prescription, full-time spectacle lens wear is not feasible for this patient and she is now comfortable in her contact lenses. She continues to wear her spectacles with the bandage lenses one to two days a week.

This case highlights the benefits that daily disposable lenses have for dry eye patients, in providing an environmental barrier for aqueous deficient and evaporative dry eye conditions. We have also used the same treatment for three other recent patients, all females in their teens or early twenties, for whom conventional lubrication therapy did not relieve their symptoms or clinical signs. After some initial adaptation time, all have had positive results.

A recent study has shown that daily disposable lenses, in this case Alcon Dailies AquaComfort Plus,[1] provided improved ocular comfort and reduced clinical signs in patients with ocular allergies. While traditionally both ocular allergies and dry eye syndromes have precluded successful contact lens wear, daily disposable contact lenses should be kept in mind for the possibility of therapeutic use for these groups of patients. ■

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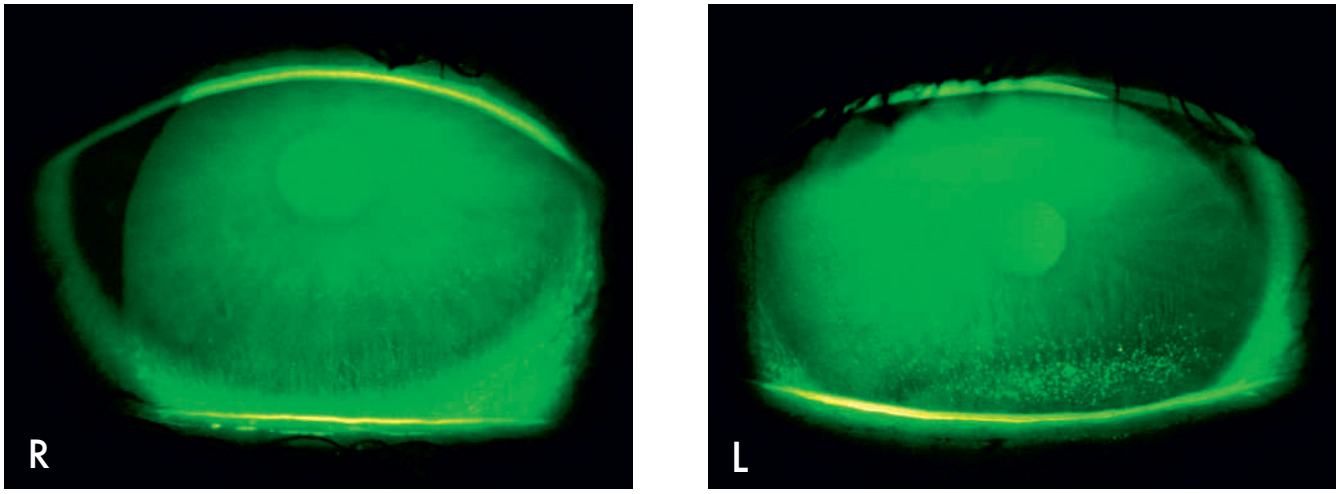

Figure 2. Right and left eyes, respectively, of patient DK showing near resolution of inferior SPK after six months of bandage lens use

Lessons to learn about pterygium

4 Case reports

1. The first attempt at removal has the best chance of success

A 55-year-old man who was first seen by me in 2002 has had over 16 pterygium operations, approximately four on each of the left and right nasal and temporal pterygia over a 30-year period. Treatment included radiotherapy. His vision has been significantly affected with best-corrected vision of 6/15 on the right and 6/12 on the left (Figures 1 and 2).

On the right eye, both his nasal and temporal pterygia measured 4 mm onto the cornea, and on the left eye the nasal pterygium was 2 mm and the temporal pterygium 4 mm.

I undertook P.E.R.F.E.C.T. for PTERYGIUM surgery on his right nasal pterygium in August 2002, left temporal pterygium in February 2003, right temporal pterygium in August 2003 and finally his left nasal pterygium in June 2004.

When last seen in August 2005, he had no recurrence with a modest cosmetic result and his vision had improved to 6/12 on the right and 6/7.5 on the left (Figures 3 and 4).

LESSONS

- The first go at a pterygium is the best chance for the patient
- The conjunctival autograft can be successfully reharvested from above more than once if at least six to 12 months are left between the retrievals
- The cosmetic result after so many removals is not as good as after a successful first removal. Nonetheless, the patient is extremely happy.

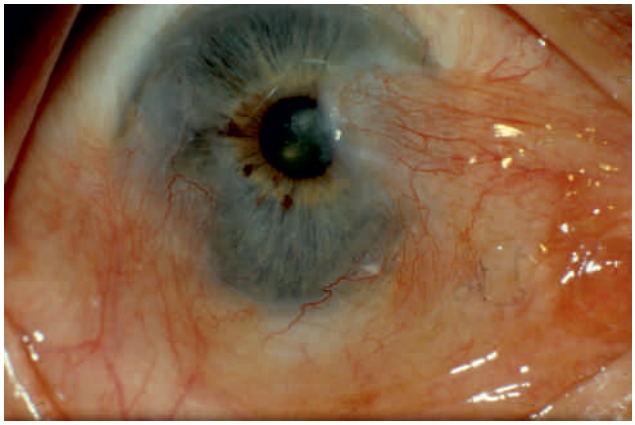

Figure 1

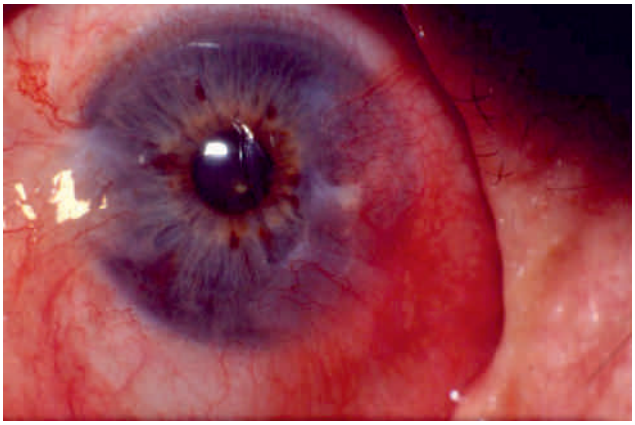

Figure 2

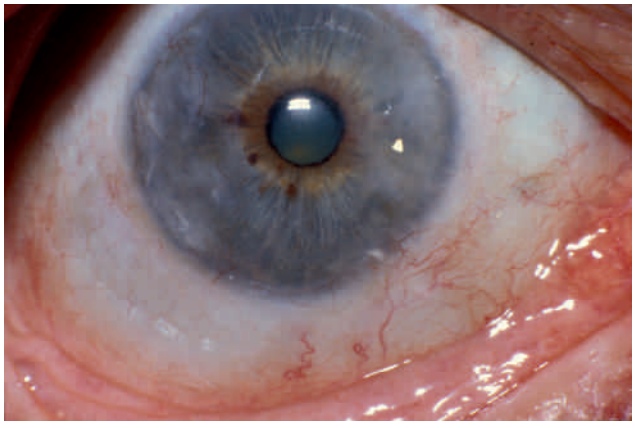

Figure 3

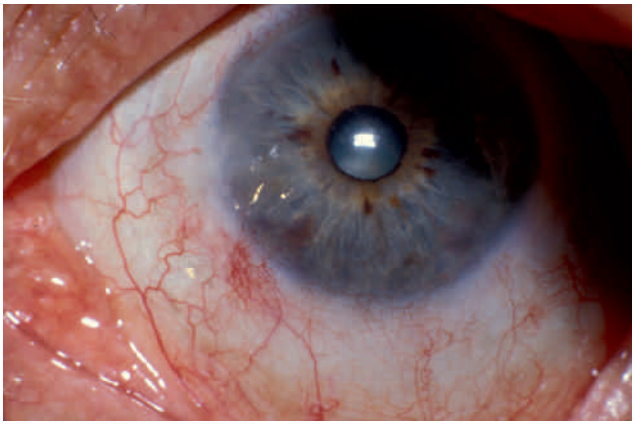

Figure 4

Professor Lawrie Hirst
MBBS(Qld) DO(Melb) FRANZCO
FRACS MD(Qld)
MPH(Johns Hopkins)
CEO The Australian Pterygium Centre

There is compelling evidence that one of the principal aetiologies in the development of pterygium is exposure to sunlight, especially in the first 10 years of life. A child growing up for the first 10 years of life in Queensland has a 40 times increased risk of developing a pterygium compared to a cousin growing up for the same period of time in Victoria. This is as a result of the increased sunlight exposure in Queensland compared to Victoria.

The diagnosis of pterygium is straightforward but a casual observer may confuse a simple pinguecula with an early pterygium. Otherwise, any growth of tissue over the nasal limbus is most likely to be a pterygium.

Not all pterygia require removal. The main indications are any visual change that can be attributed to the pterygium, constant irritative symptoms that are likely to be caused by the pterygium, any pterygium over 2.5 to 3 mm in size even if asymptomatic, and cosmetic concerns even with small pterygia. Occasional pterygia may require removal because of atypical features, strabismus or the frequent use of over-the-counter vasoconstrictor drops.

If lubricants and occasional over-the-counter therapeutic drops keep the symptoms at bay and the pterygium is not large, then this may be all the patient needs. It is impossible to predict the growth of a pterygium and many may stay totally stationary and may not need any surgery.

2. Never give up

A 48-year-old truck driver was first seen in 2008 after having had nine previous removals of his left nasal pterygium (Figure 5). He was no longer able to drive a truck and was resigned to living with his 5 mm recurrent nasal pterygium for the rest of his life. In February 2009 he had his 10th pterygium removal using P.E.R.F.E.C.T. for PTERYGIUM, which was about as difficult as it can be with virtually no nasal conjunctiva with which to work. His vision improved to 6/6 within two months and over one year later, there was no recurrence and the patient was very happy (Figure 6). So was I.

LESSONS

- The more times a pterygium is removed, the more difficult subsequent removals will be but never give up, as P.E.R.F.E.C.T. for PTERYGIUM has successfully dealt with more than 200 recurrent pterygia with only two recurrences.
- If you want to be sure that a pterygium is not going to return, then the patient should be followed for at least one year. Our studies show that 97 per cent of all recurrence starts within the first year after surgery.

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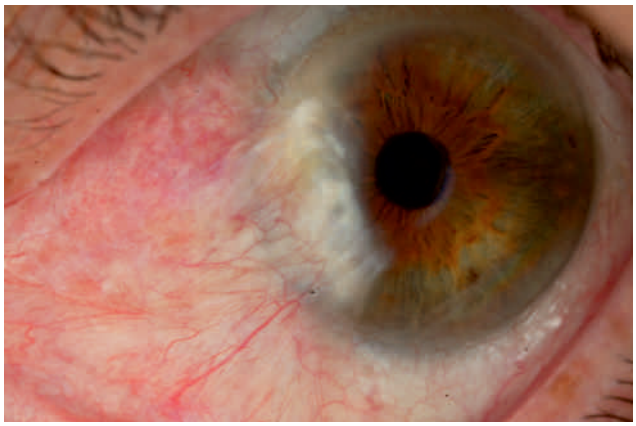


Figure 5

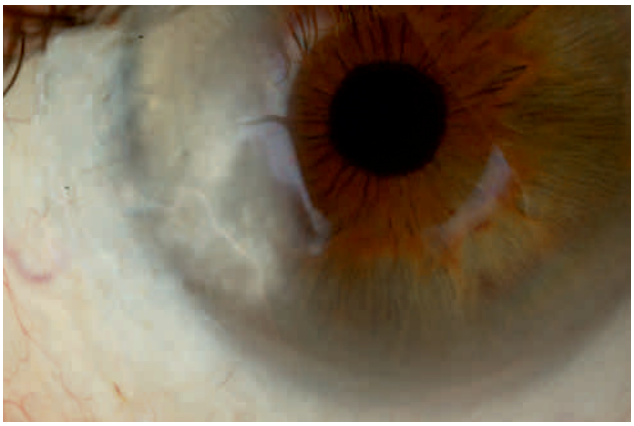


Figure 6

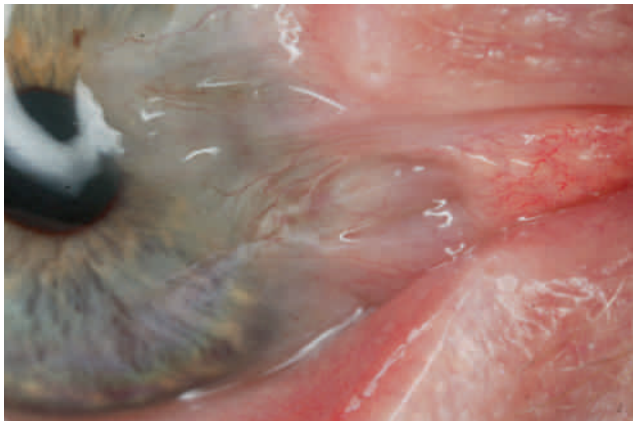


Figure 7

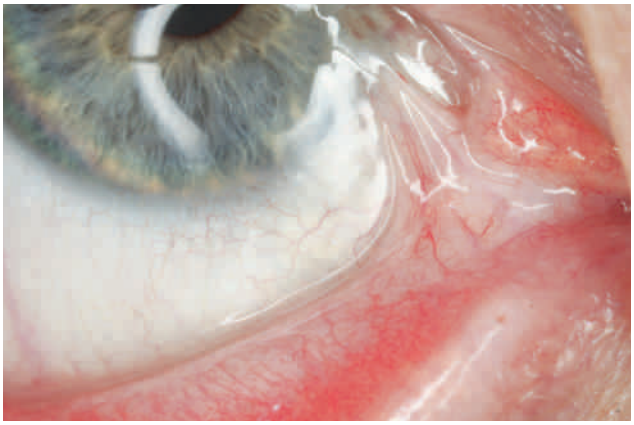


Figure 8

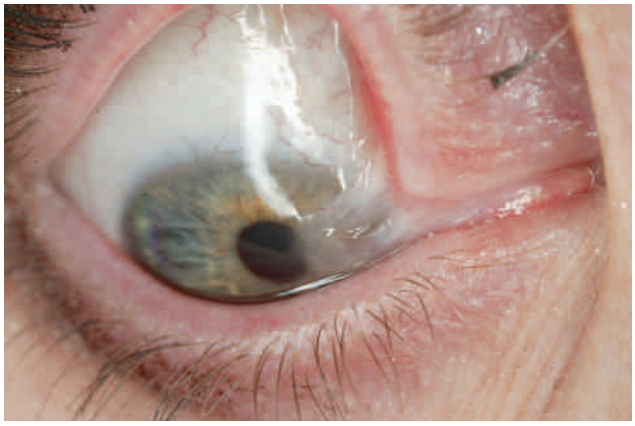


Figure 9

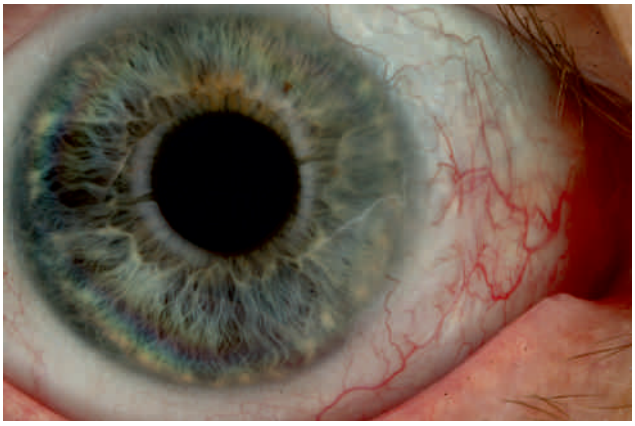


Figure 10

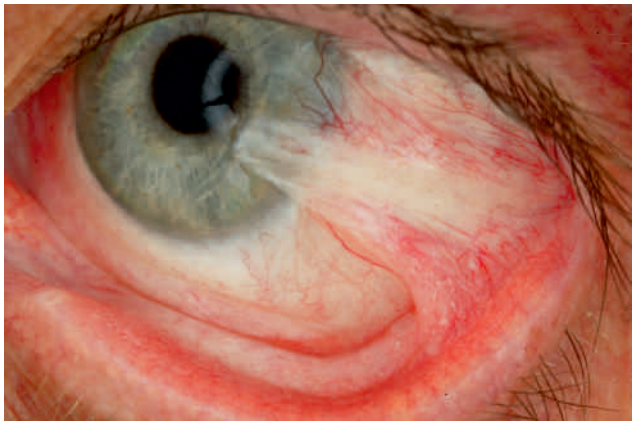


Figure 11

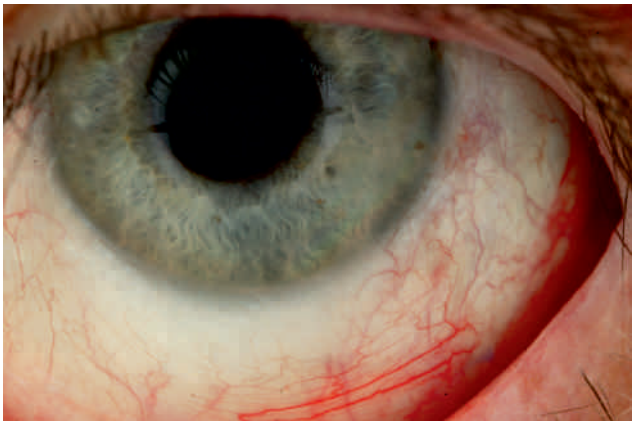


Figure 12

From page 11

3. Chemo agents necessary but risky

A 30-year-old flight attendant presented in November 2011 with a history of two previous removals of her right nasal pterygium in 2008-2009 in the USA, with amniotic membrane and mitomycin. A severe recurrence was limiting her abduction of the right eye and causing disabling diplopia and a grossly unpleasant-looking eye (Figures 7, 8 and 9). Her upper lid was adherent to the globe and the caruncle was pulled temporally to the limbus.

In November 2011, the eye was released with P.E.R.F.E.C.T. for PTERYGIUM although the upper lid remained slightly adherent to the globe with a further surgery to release this performed in July 2012. She now has virtually full movement of the eye and a reasonable cosmetic appearance (Figure 10).

LESSON

- Amniotic membrane has an unacceptably high recurrence rate unless combined with chemo agents such as mitomycin, which in itself poses the potential for significant short-term risks of scleritis and long-term risks of scleromalacia.

4. Vision reduced for unusual reasons

A 48-year-old man presented in April 2012, having had simultaneous removal of his left nasal and temporal pterygia seven years previously, in the office, apparently scraped off.

He has had restriction of his left adduction by the recurrent temporal pterygium. His nasal pterygium had also recurred (Figure 11). When looking to the right, his left cornea buckled under the tension of the tethering effect of the recurrent temporal pterygium so that when he looked right his vision was distorted.

In June 2012, his recurrent temporal pterygium was removed using P.E.R.F.E.C.T. for PTERYGIUM with a good result and resolution of his corneal buckling and tethering (Figure 12).

LESSON

- Vision can occasionally be reduced for unusual reasons in an eye with a pterygium. ■

Fabry disease and the role of optometrists

Early diagnosis of the disease can help not just your patient but their family, too.

Dr Charles P Denaro
Director, Internal Medicine and Aged Care, Royal Brisbane and Women's Hospital
Associate Professor, University of Queensland

Fabry disease is a rare genetic disorder with life threatening consequences for middle-aged adults. Optometrists can play an important role in diagnosing this disease. Not only can they identify the condition in their patient, but also the diagnosis will lead to subsequent family screening, which is highly likely to find many other asymptomatic yet affected family members. This will allow the early institution of life-saving therapy for many people.

Illustrative case

A 26-year-old male developed 'heat exhaustion' and required urgent medical attention. Investigations revealed an abnormal heart, the cause of which was not clear. When asked whether there was a history of any diseases in the family, the patient was unaware of any problems but asked his father. His father remembered that his wife had seen an optometrist some years before and a possible condition in the family was mentioned. He searched for the letter from the optometrist and found the word 'Fabry'. It became clear that the patient, the patient's mother and his three siblings had Fabry disease and required therapy.

Background

In 1898 two doctors, Anderson and Fabry, independently first described the skin changes of Fabry Disease.[1,2] Anderson is often forgotten and the term Anderson-Fabry Disease is rarely used. Fabry is a rare inherited X-linked lysosomal storage disease (LSD). There are at least 70 different LSDs and about one in 5,000 live-born infants has a LSD, with Gaucher and Fabry disease the most common.[3]

Lysosomes are intracellular organelles which are predominately involved in recycling (breaking down) endogenous or exogenous macromolecules as well as micro-organisms. In the case of Fabry disease, there is a deficiency of the enzyme alpha galactosidase, which is involved in the breakdown of sphingolipids, an important component of cellular membranes.

The predominant molecule that accumulates is globotriaosylceramide (called GB3 or GL3 or CTH). This substance accumulates in the lining of blood vessels and virtually all visceral tissues in the body.[3] Even though the Fabry gene is located on the X chromosome, both males and females get this condition. In most but not all cases, the males are more severely affected and affected earlier in life. At least 600 different mutations of the gene have now been described.[4] In general, families carry the same mutation. Being X-linked means that fathers with the mutated gene must give this abnormal gene to all of their daughters but none of their sons, while mothers have a 50 per cent chance of giving it to their children of either sex.

It had been thought that Fabry was very rare, with an estimated prevalence of about one in 100,000. Recent neonatal screening programs in Italy, Taiwan and Austria suggest that the frequency of finding the mutated gene is much more common: one in 3,000 to one in 6,000.[5,6] Whether all with the mutation will develop frank disease is yet to be determined.

Without a known family history, it is a difficult diagnosis to make. Symptoms often start in childhood with the classic acroparesthesia (pain in the extremities) and these symptoms are often attributed to 'growing pains'. However, very often these symptoms abate in early adulthood and patients can be relatively asymptomatic yet continue to have progressive organ damage or present with a catastrophic event such as a disabling stroke, end-stage kidney failure requiring dialysis or sudden death. Registry data suggest that diagnostic delays from first symptoms to diagnosis take on average 15 years and on average, 10 specialists are consulted in the intervening period.[7,8]

Because eye signs are very common in Fabry disease, optometrists and ophthalmologists have an important role in identifying this hazardous and life-shortening condition.

General clinical features

In the past, patients died most commonly of renal failure, but now cardiovascular and cerebrovascular complications lead to significant disability and premature death. Untreated males and females have a life expectancy of 50 and 70 years, respectively.[4]

Eye signs

Changes consistent with Fabry disease are seen in the cornea, conjunctiva, lens and retina. Usually, they appear in the second decade of life, though case reports of much earlier presentations exist.[9,10] Ocular findings usually do not interfere with visual acuity.[4]

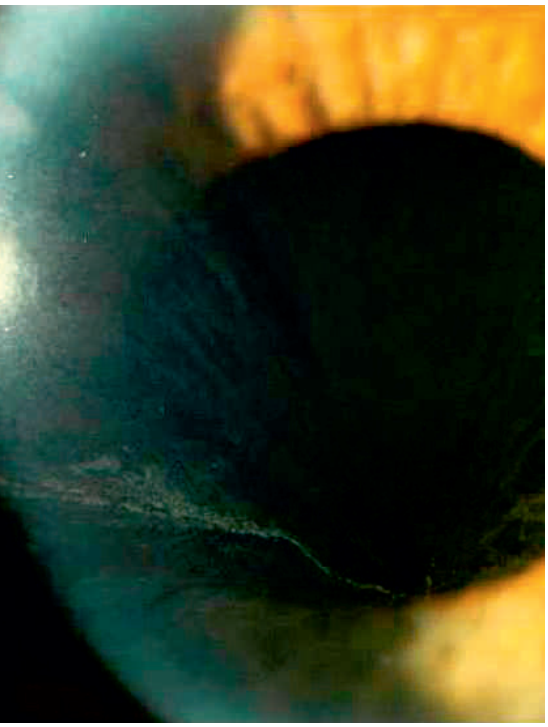
Cornea

The most characteristic and usual ocular finding is cornea verticillata.[8] This is a whorl-like opacity seen under slitlamp examination, usually deriving from an inferior part of the cornea. It is often cream coloured. At an early stage, the changes resemble a fine diffuse epithelial haze.[11] The reported frequency of finding this abnormality is between 53 and 94 per cent.[8,11] The lesion is easily missed unless the slitlamp beam is carefully angled to view the corneal epithelium.[8] There are other causes of this lesion, particularly long-term therapy with a number of medications.[8]

Continued page 14

Fabry disease

From page 13



Verticillata (horizontal) and haze (vertical)

Conjunctiva

Changes to the vessels overlying the conjunctiva are also very common. The changes consist of dilated and tortuous venous vessels, with irregular calibre and aneurysm formation.[11] The changes are best seen inferiorly. They are not specific and can be seen in diabetic patients as well as other conditions.[8]

Lens

Both anterior and posterior lens opacities have been described.[8] Linear, whitish almost transparent deposits of GB3 on or near the posterior lens capsule are unique to Fabry disease and are sometimes referred to as 'Fabry' cataracts. A full pupil dilatation is required to evaluate the changes of lens transparency as the discrete opacities can be easily missed if the entire lens capsule is not examined.[12]

Retina

Venous vessel tortuosity is the most common finding. It is more frequent in patients with a higher burden of disease.[13] There have been several reports of loss of vision secondary to central retinal artery occlusion as well as rare reports of optic atrophy and other retinal ischaemic syndromes.[8] Enlarged blind spots have also been reported in 39 per cent of patients in one study.[12]

Diagnosis

The diagnosis is straightforward in men as they will all have low levels of alpha galactosidase in their blood. The assay is available in Brisbane and Adelaide. For females it is much more problematic. Since they have two X chromosomes, (only one with the mutated gene) the enzyme level can be normal or low. Normal levels do not preclude females from suffering from the complications of Fabry disease. Direct mutation analysis of the gene is required and blood needs to be sent to the National Reference Laboratory, Department of Genetic Medicine SA Pathology in Adelaide.

Optometrists and ophthalmologists are often the first to diagnose the condition. In a retrospective analysis of 50 male patients with no family history of the disease[13] (26 per cent) were diagnosed by an ophthalmologist.[14] The Fabry Registry, an ongoing, observational database funded by the company Genzyme, reveals that ophthalmologic signs were the presenting features of the disease in 11 per cent of patients.[15]

Treatment

While the management of patients affected by Fabry disease is complex and multimodal, the great breakthrough in treating these patients has been the advent of Enzyme Replacement Therapy (ERT). This therapy is replacing the deficient enzyme with a recombinant human enzyme product that is almost identical to the original enzyme.

The product is very difficult to produce and as a result, very expensive. The therapy is life-long, requires intravenous infusions and is funded in Australia by the Australian Government's Life Saving Drug Program. ERT has been shown to clear GB3 from cells, especially endothelial cells, and change the course of the disease progression.[16,17] While it is still early days, the use of ERT early in a patient's life may mean Fabry patients could have a normal life span with good quality of life.

Conclusion

As a specific therapy exists for Fabry disease, all potential patients now need to be identified. In many cases the disease is relatively asymptomatic in patients before it is too late to prevent complications. Optometrists can play an important role in finding these patients and their affected family members and help prevent the complications of this admittedly rare but life-threatening condition.

Acknowledgement

I thank Dr Langis Michaud, OD MSc FAAO (Dipl), for the use of the Figure for this article. He is the Associate Professor, Chairman Contact Lens Dept, Clinical Research, École d'optométrie de l'Université de Montréal.

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Corneal verticillata or vortex keratopathy

The whorl-shaped linear opacities caused by Fabry disease are best observed against a black, dilated pupil.

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Case report

Corneal verticillata and vortex keratopathy are terms describing a whorl-shaped series of linear opacities in the deep corneal epithelium, and are caused by the X-linked recessive sphingolipidosis Fabry disease, or a phenocopy of this due to the taking of certain drugs. These include chloroquine, hydroxychloroquine, amiodarone, chlorpromazine, indomethacin, tamoxifen, naproxen, suramin and tilorone.

A 52-year-old white female, JM, attended the optometrist for a routine eye examination. She had a significant compound hyperopic astigmatic prescription and had been wearing glasses and having regular eye examinations since the age of 12 years from both optometrists and ophthalmologists. She had not consulted this practitioner before. The optometrist discovered unusual epithelial whorl-shaped opacities in each cornea with slitlamp examination, not only in this patient but also in her daughter who had accompanied her. The opacities had no effect on vision. The patients were referred to the author for a second opinion.

JM's right cornea is shown in Figures 1 and 2. It is difficult to delineate the whorl configurations (Figure 1) unless the pupil is dilated to provide a suitable background, and sclerotic scatter is used (Figure 2).

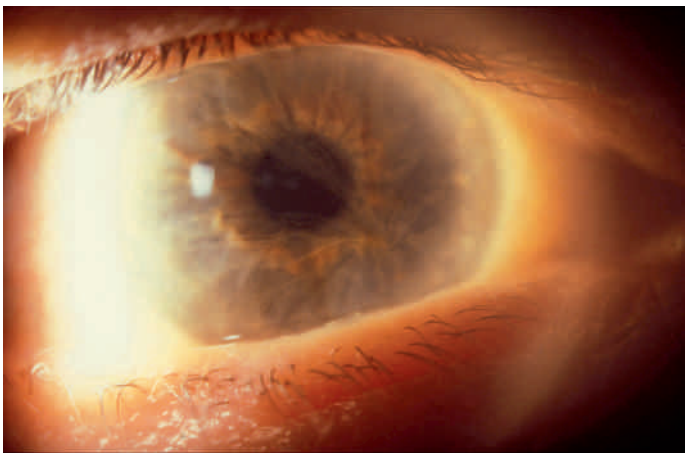

Figure 1. The whorl opacities are more difficult to see against a lighter iris background

Figure 2. Dilating the pupil and using sclerotic scatter makes observation of whorl opacities easy

Both patients denied using any of the drugs that may cause this appearance.

Family history revealed that JM also had two male children. The oldest had suffered considerable medical difficulties when young, which centred around severe and often debilitating acroparesthesias in his limbs, especially in warmer weather and when he had a febrile illness. Common analgesics offered little relief and all manner of obtuse medical diagnoses were promulgated.

Continued page 16

Corneal verticillata or vortex keratopathy

From page 15

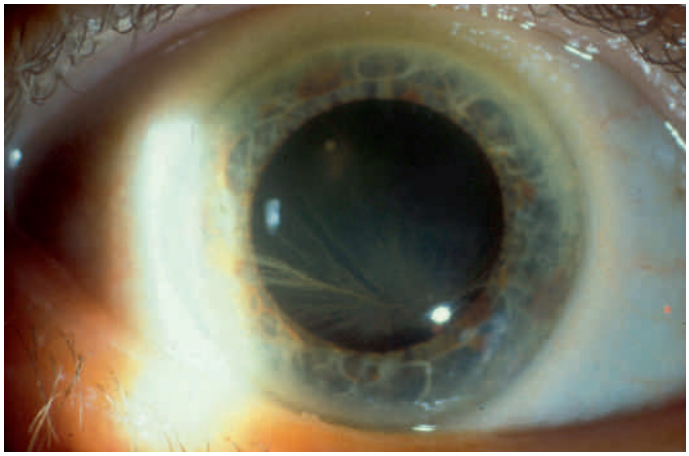

Figure 3. Whorl opacities in an elderly male patient from taking amiodarone; the pupil is dilated and sclerotic scatter is used

The painful episodes settled somewhat as he approached adulthood. He was 26 years of age when his mother and sister were examined. None of the patients had evidence of the so-called Fabry cataract or any anterior or posterior vascular changes.

It appeared to the author that these patients either had or carried Fabry disease and appropriate investigations were initiated. Subsequent testing revealed that the 26-year-old male had Fabry disease while his mother and sister carried the condition. His younger brother had normal levels of the enzyme alpha galactosidase (see page 13: Charles P Denaro's article 'Fabry disease and the role of optometrists').

Ten years later, the male patient died suddenly of a heart attack. This whole sequence of events took place before the establishment of effective enzyme replacement therapy.

As far as the author is aware, no other Fabry patients or carriers were conclusively identified in the family, JM's mother and father having died 27 and 25 years, respectively, prior to the initial examination. However, JM's daughter was pregnant with her first child when the author last had contact with the family some years ago. The foetus was male and there was a 50 per cent chance that he would also develop Fabry disease.

Comment

Fabry disease, together with its systemic and ocular manifestations, inheritance pattern and potential treatment, has been discussed by Denaro in this issue of *Optometry Pharma*.

It is important to note that despite many eye examinations, it took a very long time for JM's characteristic corneal opacities to be detected. Was this the first time biomicroscopy had been included in her eye examination? Corneal changes such as these, especially in patients with lighter irides like JM, are best observed against the black backdrop of a dilated pupil, with sclerotic scatter being a preferred slitlamp technique.

As noted above, several drugs can cause a phenocopy of the corneal verticillata of Fabry disease. The elderly male patient illustrated in Figure 3 was taking cardarone, otherwise known as amiodarone, and this had caused the whorl opacities. Considering his history and age, he did not have Fabry disease. The opacities were not affecting his vision. Optometrists should remember that these drugs can also cause other, potentially more important ocular problems such as the possibility of an optic neuropathy with amiodarone, bulls eye-like pigmentary abnormalities at the macula with chloroquine and hydroxychloroquine, and cataract with chlorpromazine. If the causative agent is withdrawn, the corneal opacities disappear with time.

Denaro points out the potential role of optometrists and ophthalmologists in diagnosing Fabry disease. This is undoubtedly true, provided slitlamp biomicroscopy forms part of every eye examination. Fabry disease is a life-threatening illness. It is very difficult to find in the literature many Fabry males older than 50 years. Some patients are relatively asymptomatic and therefore their identification at a young age, allowing the early institution of enzyme replacement therapy, is essential.

Acknowledgement

The author acknowledges the contributions of Aphrodite Livanes, Anthony Phillips and Christine Wildsoet in the identification and investigation of the patients and their family. ■

Metabolic eye disease

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Inborn errors of metabolism (IEM) are a heterogeneous group of genetic diseases that result from a defect in the function of an enzyme important for metabolism. Individually they are rare but collectively they affect roughly one in 5,000 individuals.[1] This deficiency generally causes systemic effects as a result either of the toxic accumulation of an intermediary of metabolism, from deficiency of a substrate, or from toxic secondary metabolic pathway effects. Many organ systems of the body can be affected, including the eye.

Optometrists and ophthalmologists can play an important role in both the diagnosis and management of these conditions. It is therefore important to be aware of both the ophthalmological features and systemic presentations of such disorders. This will facilitate a rapid diagnosis and enable appropriate management, as well as genetic counselling, advice and testing.

Currently within Australia, the introduction of expanded newborn screening in the early to mid-2000s has enabled a number of IEMs to be diagnosed within the neonatal period. Individuals with these conditions will therefore be presenting to optometrists for management and monitoring. It is important to be aware that such screening does not detect all IEM. Homocystinuria, for example, is not reliably detected.[1] Australia is currently not screening for lysosomal disorders. Optometrists may be the first point of contact for patients with these disorders, and can enable the early diagnosis of such conditions.

IEM may affect different parts of the eye, including the cornea (corneal clouding), retinal degeneration, lens defects and optic atrophy. This review covers each aspect of these complications.[2] When suspecting an IEM, general principles to consider are that the eye begins to be affected early in life, both eyes are usually affected to an equal severity and the changes are frequently progressive. The exact pathological processes leading to the eye abnormalities of IEM are not well understood.[3] It has been postulated that the damage may result from direct toxic effects of accumulating metabolites, from abnormal energy metabolism or from structural changes from abnormal synthetic pathways.[3]

Cornea

The cornea comprises a number of layers, all of which can be affected, resulting in staining or clouding. If the IEM results in accumulation of a metabolite within the corneal cells themselves, there will be a generalised affect on the cornea. This is opposed to a metabolite raised in the blood alone, when the periphery of the cornea is involved.[4]

A number of lysosomal storage disorders, in particular the mucopolysaccharidosis (MPS), result in progressive corneal clouding (Figure 1). The mucopolysaccharidoses are a heterogeneous group of disorders that result from a deficiency in an enzyme involved in the metabolism of glycosaminoglycans (long chains of complex sugars). These sugars are important in the connective tissues within the body, and they progressively accumulate when the enzyme is deficient. This manifests as a progressive multi-system disease with characteristic coarsening of the facial features, joint disease, organomegaly and variable neurological involvement. Dermatan and keratan sulphate accumulate in the keratinocytes of the cornea leading to characteristic clouding with a ground glass appearance. This is seen primarily in MPS type I, IV, VI and VII. Those that store heparin sulphate are more likely to have retinal disease. The MPS disorders are also associated with risk of development of glaucoma, cataracts, pigmentary retinopathy and optic nerve swelling leading to atrophy.

Fabry disease

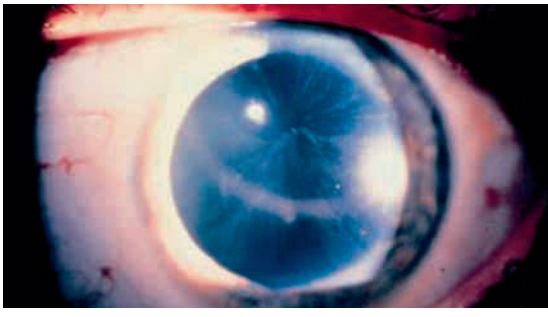
Fabry disease is another lysosomal disorder lending itself to diagnosis as a result of an ophthalmological examination. It is an X-linked disorder resulting from deficiency in α-galactosidase activity, with glycolipid accumulation. Carrier females have variable symptoms (relating to the degree of X inactivation). Males potentially suffer severe multi-organ dysfunction. Although the ocular manifestations of the disease do not cause problems, the ocular findings may be the only feature identifiable. Ocular manifestations begin as a diffuse haziness and progress to lines radiating from the periphery to the centre, known as vortex keratopathy or cornea verticillata (Figure 2). This feature is present in 70 per cent of Fabry patients.[4] Certain medications can give a similar picture. Conjunctival and retinal vessel tortuosity can also be variably identified in Fabry individuals.

Other lysosomal disorders

A number of additional lysosomal disorders present with corneal clouding including oligosaccharidoses (sialidosis, galactosialidosis, alpha mannosidoses, fucosidoses), multiple sulphatise deficiency, mucolipidosis, fish-eye disease and Wilsons disease.[3,5]

Continued page 18

Figure 1. Typical corneal clouding with ground glass appearance of the mucopolysaccharidoses. This appearance is observed in MPS type I, IV and VI.



Figue 2. Vortex keratopathy or cornea verticillata identified in female and male Fabry individuals. This may be the only feature of the condition present in a female Fabry carrier.

Metabolic eye disease

From page 17

Three forms of tyrosinaemia have been identified: types I, II and III.

Tyrosinaemia II, due to a deficiency of tyrosine aminotransferase, typically presents with corneal lesions and symptoms of photophobia with red, watery eyes. This disorder results in the accumulation of tyrosine within the blood and crystal formation of the amino acid within the cornea with secondary ulceration and irritation. Frequently painful hyperkeratotic lesions occur concurrently on the palms and soles. Both the eye and skin respond to lowering of tyrosine level by dietary modification. Tyrosinaemia type I is associated with severe liver disease. Treatment with NTBC prevents the liver disease but results in increased tyrosine levels, associated with corneal lesions if levels are sufficiently high. Dietary modification allows control of this problem.

Cystinosis, due to a deficiency of lysosomal carrier protein cystonin, presents with painful photophobia as a result of cystine crystal deposition and erosions of the cornea (Figure 3). This can be the first feature of the disorder before systemic symptoms such as renal failure develop.

Figure 3. Cystine crystals present in cystinosis

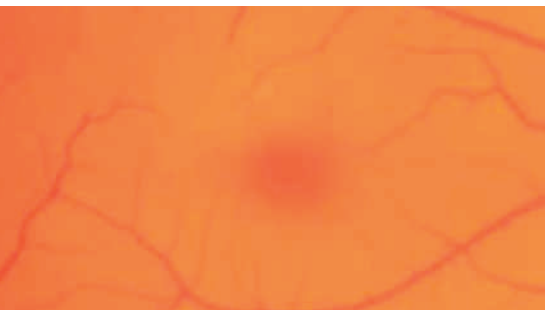


Figure 4. Cherry Red spot identified in lysosomal storage disorders (sialidosis, galactosialidosis, gangliosidosis–GM1 and GM2, Nieman-Pick A, Gaucher type 2, Farber lipogranulomatosis, meachromatic leukodystrophy)

Lens

Opacification of the lens or cataracts is a feature of disorders involving carbohydrate metabolism (galactose and polyols), peroxisomal biogenesis, cholesterol biosynthesis and amino acid transport conditions.[4,6,7] There are three forms of galactosaemia, all of which can develop cataracts. In the avascular lens, accumulated galactose is reduced to galactitol. This polyol acts to cause increased intracellular fluid with consequent swelling and disruption of the lens structure leading to cataracts. Such cataracts respond to galactose reduction in the diet.

The lens also has a high content of cholesterol and not surprisingly, is affected in cholesterol biosynthesis disorders such as mevalonate kinase deficiency, Smith-Lemli-Opitz syndrome and Conradi-Hünermann syndrome.[4] Cerebrotendinous xanthomatosis (CTX), a disorder of bile acid metabolism, causes impaired conversion of cholesterol to colic and chenodeoxycholic acid. Affected individuals will have xanthomatosis, neurological abnormalities and cataracts.

The lens may also be dislocated in IEM involving sulphur pathways such as homocystinuria, molybdenum cofactor deficiency and sulphite oxidase deficiency. Homocystinuria is due to a defect in cystathionine beta synthase leading to abnormal accumulation of homocysteine with affects on tissue elasticity. Individuals have a body habitus similar to that seen in Marfan syndrome and develop lens dislocations. The ectopia lentis of homocysteinuria is due to zonular stretching and degeneration as a result of homocysteine accumulation. Unlike Marfan syndrome, the lens dislocation is a downward displacement.

Retinal

Retinitis pigmentosa is characterised by progressive loss of peripheral vision and difficulties with night vision. Aetiology is remarkably variable as it may occur as a primary disorder or result as a secondary effect. The retina is prone to damage in IEM, typically from either direct toxic effects or deficient energy metabolism, which occurs as a complication in the following general groups of disorders: an error in lipid metabolism, lysosomal function, mitochondrial energy metabolism or copper metabolism.[4,7]

Gyrate atrophy, due to a deficiency of ornithine amino transferase (OAT) results in elevated levels of ornithine in many tissues. The photoreceptors of the retina are particularly sensitive, with slowly progressive retinopathy developing with eventual visual loss. Affected individuals often present with a history of loss of night vision and myopia. Lesions begin as small areas but progress to larger circular demarcated regions of chorioretinal degeneration. Eventual progression to involve the whole retina results in blindness. Treatment is aimed at slowing the process by reducing ornithine either by replacing the enzyme's cofactor pyridoxine or in unresponsive cases, with diet.

The neuronal ceroid lipofuscinosis (NCL) are a heterogeneous group of neurodegenerative disorders associated with typical retinal abnormalities. Retinitis and hearing loss are associated with the peroxisomal disorder Refsum disease. The mitochondrial syndrome Kearns-Sayer consists of ophthalmoplegia, ptosis, heart block and later-in-life retinitis. Abetalipoproteinemiah, resulting from a lack of apolipoprotein B, leads to fat malabsorption and secondary fat soluble vitamin deficiency. Untreated, these deficiencies will lead to progressive retinitis pigmentosa.

Increasingly, the occurrence of retinal disease as a complication of the disorder has been recognised in a number of IEMs, such as the organic acidurias and cobalamin C disease. This may reflect improved identification and management of these conditions with patients potentially surviving longer.

The appearance of cherry red spots in the macula of the eye should lead one to suspect a group of lipid lysosomal storage disorders (Figure 4). These spots occur early in the course of the disease and result from the deposition of storage material within the cellular layers of the retina. Ganglion cells are absent in the fovea, which is spared, allowing the red choroid to be visualised surrounded by white diseased cells. The presence of these spots provides an early opportunity to diagnose this group of conditions.

Summary

While many inborn errors are individually rare, as a group, they occur relatively frequently. It is important to have a high index of suspicion to allow prompt early diagnosis and management. Confirmation of these disorders usually requires specific biochemical, enzymatic or molecular investigation. Referral to a metabolic specialist trained in the diagnosis and management of inherited metabolic disorders is recommended.

References are available from j.megahan@optometrists.asn.au. Subject: IEM, Pharma December 2012.

Acute solution toxicity

in mini-scleral contact lens wear

Case report

If you believe the marketing, all contact lens cleaning solutions are wonderfully biocompatible, yet clinical experience and literature demonstrate that solution toxicity is a possible adverse event in all forms of contact lens wear.[1] The conversation surrounding solution toxicity generally revolves around epithelial toxicity in the form of supposed solution-induced corneal staining (SICS) and subepithelial events such as infiltrative keratitis (IK) in soft contact lens wear. As the use of mini-scleral contact lenses rises, so does the potential for acute solution toxicity due to increased contact time between the solution and the ocular surface. This case discusses the aggressive treatment required when we encounter an event such as this.

History

A 25-year-old male presented with bilateral red and watery eyes since waking. He was substantially photophobic. The patient had been seen in the practice two months prior, when he had been fitted with 16.5 mm diameter mini-scleral contact lenses for the correction of keratoconus.

The patient had no known general health conditions or allergies. His prescribed lens-wear regime included instructions to rinse and fill his mini-scleral lenses with only Lens Plus brand saline but 24 hours prior to presentation, the patient had filled his lenses with a rigid lens conditioning solution because he had run out of saline.

Examination findings

The patient demonstrated bilateral grade 3 bulbar conjunctival hyperaemia with grade 2 limbal injection. There was no discharge noted in either eye. Corneas were affected by diffuse superficial punctate keratopathy (SPK) as well as substantial leukocyte infiltration throughout 360 degrees in each eye peripherally. There was no anterior chamber reaction or stromal oedema. Intraocular pressure was 12 mmHg right and left at 8:30 am.

Diagnosis and treatment

The examination findings and history indicated a diagnosis of a toxic inflammatory response bilaterally. There were no signs of infection. The patient was prescribed prednisolone acetate 0.1% every two hours while awake, as well as non-preserved lubricants every hour with review scheduled for 24 hours. The patient was advised to cease lens wear until review.

At the 24-hour review, the patient's SPK, leukocyte infiltration and conjunctival hyperaemia had substantially improved. The patient reported a notable reduction in symptoms. Treatment was maintained at the same dose for another 24 hours.

At the 48 hour review, the patient's clinical signs had resolved. The patient was instructed to resume contact lens wear (remove if any discomfort) and begin a rapid taper of the prednisolone to three times per day for 24 hours, twice per day for 24 hours, then night time only for two days. Unpreserved lubricants were to be continued as needed. The patient was re-educated in the necessity to fill his lenses only with a non-preserved or Ocupure preserved saline or eye-drop.

Discussion

Contact lens solution toxicity results in an ocular inflammatory response which can vary from barely noticeable to hyperacute.[2] Varying degrees of therapy can be required depending on the severity of the condition and the patient's dependence on contact lens wear. Treatment typically consists of one or more of the following: ceasing lens wear, lubricants and corticosteroid eye-drops.

The rate of tear exchange under mini-scleral lens designs ranges from slow to negligible. Tear exchange is slowest in those lenses which make 360 degree contact with the conjunctiva. In lenses of this type, it is very important that patients rinse and fill their lenses with the appropriate solutions prior to insertion. Any solution or preservative left on the lens at the time of insertion may remain in contact with the ocular surface throughout the entire time of lens wear and be more likely to cause an acute toxicity reaction.

In the case of adverse events in contact lens wear among the keratoconic population, it is generally required that therapeutic treatment be approached aggressively. Many keratoconic patients are unable to function without their contact lenses so a practitioner must be confident in their diagnosis and pursue an appropriate but aggressive treatment. ■

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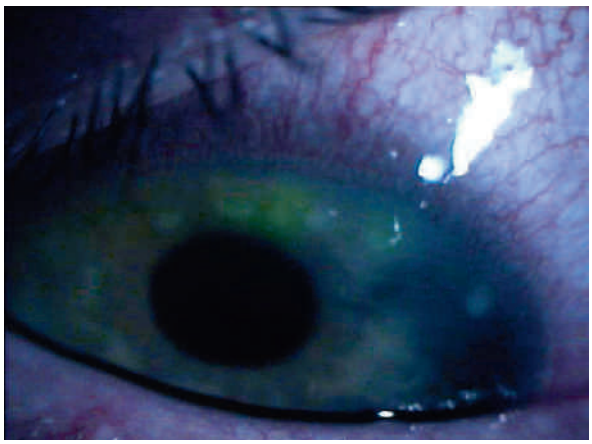
1. Complications associated with care product use during silicone daily wear of hydrogel contact lens. Papas EB et al. *Eye & Contact Lens* 2007; 33: 6: Part 2 of 2, 392-393.
2. Cytotoxicity and effects on metabolism of contact lens care solutions on human corneal epithelium cells. Choy et al. *Clin Exp Optom* 2012; 95: 2: 198-206.



Acute leukocyte infiltration of the cornea on day of first presentation

Dronedarone is easier

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Dronedarone (Multaq) is a non-iodinated benzofuran derivative of amiodarone (Cordarone, Pacerone). It is increasingly being used to reduce cardiovascular hospitalisation in the 2.2 million patients suffering from non-permanent atrial fibrillation (AF) or atrial flutter in the United States.[1] AF is the most common cardiac rhythm disturbance and is expected to increase 2.5-fold in the next 50 years.[1]

Severe consequences resulting from AF include congestive heart failure, a five-time greater risk of stroke and a two-time greater risk of mortality.[2] AF is managed by controlling ventricular rate, preventing thromboembolic events, and restoring and maintaining normal sinus rhythm. Amiodarone and dronedarone are both used for rhythm control, but dronedarone seems to have less systemic and ocular side-effects.[1]

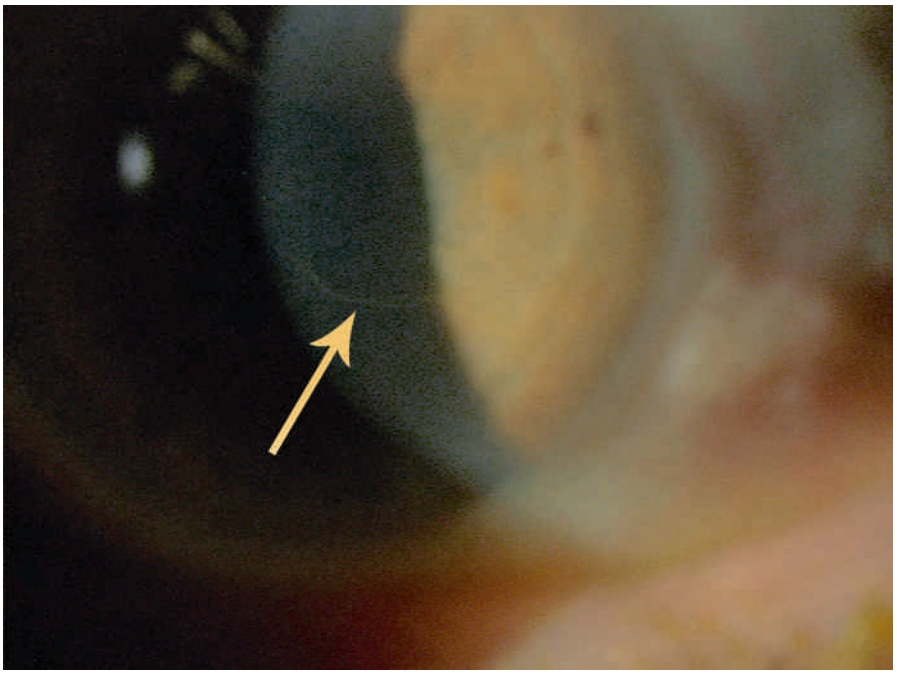
Amiodarone

Amiodarone is an anti-arrhythmia medication used to treat ventricular tachycardia and fibrillation, as well as restore the sinus rhythm in AF. Currently, amiodarone is the most effective anti-arrhythmia agent for atrial fibrillation control but it has serious side-effects.[2]

Systemically, amiodarone can cause thyroid dysfunction, pulmonary toxicity, peripheral neuropathy, gastrointestinal problems, dermatologic discoloration and central nervous system deficits.[3,4] Amiodarone has a high iodine content, which can mask thyroid abnormalities. In addition, it has multiple drug interactions due to its inhibition of cytochrome P450 enzyme and it has a long half-life of approximately 56 days, which can lead to tissue accumulation of the drug.[4]

Ocular side-effects of amiodarone include blepharoconjunctivitis, conjunctival pigmentation, dry eye, corneal verticillata, decreased corneal sensitivity, anterior subcapsular and cortical cataracts, photosensitivity, optic neuropathy and pseudotumour cerebri.[3]

Corneal verticillata, also called vortex keratopathy, is the most common ocular side-effect occurring in 70 per cent to 100 per cent of patients using amiodarone (Figure).[6] It usually appears one month after starting the medication. The deposits form due to the inability of lysosomal phospholipases to metabolise the cellular phospholipids left behind by amiodarone. This results in intracytoplasmic lamellar bodies that appear as fine golden-brown or grey punctate opacities within the basal epithelium of the inferior cornea. This progresses into horizontal lines that can resemble a cat's whiskers.



Vortex keratopathy seen in a patient taking amiodarone (image enhanced)

on the eyes

Studies suggest dronedarone has fewer ocular side-effects than amiodarone in the treatment of atrial fibrilation.

Eventually, a limbus-sparing whorl-like pattern can be observed.[6] This design can sometimes extend into the visual axis. Although vision is usually not impaired, patients may complain of seeing halos around light sources. Higher doses and longer durations of amiodarone will result in more advanced corneal deposits.[3,5] Corneal verticillata is reversible in three to 20 months after amiodarone is discontinued.[6]

Optic neuropathy is a rare side-effect of amiodarone and is not dose-related. It affects about one per cent of patients during the initial eight years of therapy and less than two per cent of patients during the subsequent 10 years.[3] A clinician must be able to differentiate between non-arteritic anterior ischemic optic neuropathy and amiodarone-induced optic neuropathy.

Non-arteritic anterior ischemic optic neuropathy generally has a rapid onset (days to weeks) that is unilateral and usually complete on presentation, visual acuities of 6/6 to no light perception and resolution of optic disc oedema within weeks.[7]

Amiodarone-induced optic neuropathy will present with a gradual bilateral onset of vision loss and 6/6 to 6/60 visual acuities, and will usually take months for the disc oedema to resolve.[7] After discontinuing amiodarone, visual field defects will generally stabilise and optic disc oedema will resolve.[7] Once amiodarone therapy is initiated, a patient should be checked every six months due to the side-effect of optic neuropathy.

Dronedarone

There are several ways in which dronedarone differs from amiodarone. The iodine group has been replaced with a methane sulfonyl component. This change decreases the lipophilicity of the medication, which shortens the half-life to 24 to 30 hours, reducing the amount of tissue accumulation.[2]

Dronedarone has been tested in various efficacy and safety studies. Overall, dronedarone lacks the ocular side-effects found in amiodarone but dronedarone may cause hepatic toxicity, bradycardia, gastrointestional (GI) upset and rashes.[1]

One of the most common side-effects of dronedarone use is GI upset. In one study, the Dronedarone Atrial Fibrillation Study After Electrical Cardioversion (DAFNE) trial, the patient drop-out rate was most often due to GI side-effects such as diarrhoea, nausea and vomiting. Another study, the Efficacy and Safety of Dronedarone for the Control of Ventricular Rate During Atrial Fibrillation (ERATO) trial, also uncovered GI disturbances as a side-effect.

In both the European Trial in Atrial Fibrillation or Flutter Patients Receiving Dronedarone for the Maintenance of Sinus Rhythm (EURIDIS) and the American-Australian-African Trial with Dronedarone in Atrial Fibrillation/Flutter Patients for the Maintenance of Sinus Rhythm (ADONIS), there were no significant differences in adverse events between the dronedarone group and the placebo group; however, a low rate of study discontinuation was most often due to diarrhoea.[2]

The randomised Double Blind Trial to Evaluate the Efficacy and Safety of Dronedarone 400 mg bid versus Amiodarone Loading Dose 600 mg daily for 28 days then 200 mg daily thereafter for at least six months for the Maintenance of Sinus Rhythm in Patients with Atrial Fibrillation (DIONYSOS) showed that dronedarone had less thyroid and neurological adverse events but more GI adverse events when compared with amiodarone. GI disturbances seem to be the most common systemic side-effect of dronedarone use.

Dronedarone is contraindicated in patients with the New York Heart Association classification of Class IV (severe) congestive heart failure. It is also contraindicated in Class III (moderate) and Class II (mild) patients who have been recently admitted to the hospital. These contraindications were found in the Antiarrhythmic Trial with Dronedarone in Moderate to Severe Congestive Heart Failure Evaluating Morbidity Decrease (ANDROMEDA) which showed an increased early mortality in patients with worsening heart failure.[1,2]

Conclusion

Even though dronedarone is less effective to prevent recurrent AF when compared to amiodarone, it does have the benefit of having less adverse side-effects for better patient tolerance.[8] It is reasonable to consider dronedarone as the anti-arrhythmic of choice for clinically stable patients who are at risk for recurrent AF. Subsequently, amiodarone may be used as an alternative medication for those patients who fail to maintain sinus rhythm with dronedarone.[1] Still, it remains unclear if dronedarone is truly the better survival option over amiodarone for AF treatment due to the lack of studies and its recent introduction to the medical world.

From an ocular standpoint, it does seem apparent that dronedarone completely lacks the ocular side-effects that amiodarone possesses. Nevertheless, only more research and time will tell if dronedarone truly spares the eyes. ■

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Contact lenses for

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Drug delivery to the eye consists mainly of four different routes of administration: injections, surgically implanted devices, systemic administration and most commonly, topical administration.[1] Each of these routes of delivery has advantages and disadvantages.

Injections are able to achieve a large, targeted dose of a pharmaceutical in a target area but require repeated injections for on-going effectiveness. This is most evident in the treatment of wet macular degeneration with current anti-vascular endothelial growth factor(VEGF) agents, in which patients can expect intravitreal injections as frequently as every month.

By far, the most common method of treating the eye is through topical therapy in the form of eye-drops.[2] Eye-drops are able to achieve a high concentration of medication within the targeted ocular tissue. Unfortunately, this method relies on patient compliance and frequent dosing to reach therapeutic concentration targets. Even with the aid of frequent monitoring and reminders, it is expected that patients on chronic ocular treatment for conditions such as glaucoma are compliant less than 50 per cent of the time.[3] There is clearly a need for alternative strategies to treating the anterior surface of the eye if compliance issues are to be dealt with effectively.

Early challenges

In response to the assortment of challenges to ocular drug delivery, the concept of contact lenses as drug delivery devices emerged. This idea is not new–there are papers published from the 1960s, soon after the introduction of soft contact lenses, postulating the application of contact lenses in such a way.[4] Contact lens technology at the time was still fairly primitive.

The challenges at that time included material development to combat a host of biocompatibility issues such as deposits, disinfection, comfort and oxygen permeability–not to mention, developing quality assurance and quality control procedures to allow manufacturers to reliably reproduce lenses from batch to batch to merely control refractive error.

Contact lenses as drug reservoirs were justifiably placed on the back-burner of contact lens research. It was not until the late 1990s that many of the contact lens developments were sufficiently advanced for other applications of contact lenses to begin to be explored.

The introduction of silicone hydrogels was seen as a great evolutionary leap forward in contact lens materials and wear. No longer was hypoxia of the eye a common complication, opening the door for the potential of safe overnight wear and expanding the usefulness of a potential drug delivery contact lens.[5] There was suddenly renewed interest in this concept–could contemporary, commercially available materials not only correct refractive error but also deliver therapeutically relevant amounts of drugs?

They could not. Surveying commercially available materials for potential drug delivery was mainly a disappointing avenue, which was not necessarily unexpected as the materials were not designed for this purpose. The lenses surveyed would generally demonstrate ability to uptake and release drugs into solutions and reach therapeutically relevant concentrations, but would deliver drugs only for a few short hours in a rapid-burst release, not a steady, consistent dosage over a long period.

Antibiotics,[6] anti-inflammatories,[7] anti-allergy[8] and non-steroidal anti-inflammatories[8] all showed similar patterns of release. New materials were clearly needed if contact lenses were to be used as drug delivery devices, specifically tailored for the delivery of pharmaceuticals for a long period.

Recent successes

Since then, the field of contact lens drug delivery has begun a rapid pace of exploration and study. Researchers in the field have identified different material development strategies to extend the release time of pharmaceuticals from these lenses.

First, the base material can be modified right at the polymerisation process. In the technique of molecular imprinting, high affinity 'cavities' or molecular memory is created within the material by polymerising in the presence of a template.[9] These 'cavities' serve to retard the diffusion of the loaded drug, which closely resembles or was used as the template.

Second, the method of drug loading into the lens can also be varied to affect release times. The drug can be encapsulated at a high concentration within a thin film, and the traditional contact lens material polymerised above and below it. The film serves as a drug reservoir that must diffuse through the contact lens material before it can be released.[10] The drug can also be loaded and attached to the contact lens surface using microemulsions[11] or cyclodextrins,[12] which serve to dissolve and encapsulate the drug, providing another barrier to drug diffusion and transport.

Third, the surfaces of commercially available lenses can be modified so that they prevent the rapid diffusion and loss of the drug. Recent studies have investigated the use of coatings or diffusion barriers and have demonstrated success in decreasing the release time of glaucoma,[13] anaesthetic[14] and anti-inflammatory drugs[15] from contact lenses.

At this stage, few believe that any one of these techniques is necessarily superior to any of the others. To achieve true, extended release times at a clinically-relevant concentration, it is likely to require the deployment of more than one strategy to be successful.

The modification of commercially available lenses provides an interesting opportunity. Because the base material has already been approved by various governmental health and regulatory agencies, the manufacturers of these drug-delivery lenses may face a shorter approval time before reaching the market.

drug delivery

Overview and recent developments

Rapid development

The field has continued to grow and expand. Simply observing the number of papers published and cited on the subject shows a clear and rapid increase in interest in drug delivery with contact lenses. The greatest development has been in the techniques used to simulate or model drug delivery from combination devices that are placed on the ocular surface. Devices have been created to simulate the flow of tears through these devices.[16]

In vivo animal studies have also begun. Two recent papers have demonstrated the superiority of contact lens drug delivery devices compared to eye-drops for the treatment of allergy in rabbits[17] and glaucoma in spontaneously glaucomatous dogs.[13] Human trials for an anti-allergy contact lens have already completed phase 1 and phase 2 trials, suggesting that a release of a combination drug delivery device may be imminent.[18]

Patient compliance

To date, compliance has not been studied in patients, at least not in any published study. There is optimism that drug-delivery lenses would have a positive effect on patient compliance if they were able to simultaneously correct refractive error, as you are tying in drug therapy to the need for refractive correction.

The issue then becomes the same for compliance with regular contact lenses—are patients going to overwear the lenses, or will the fact that the lenses are also delivering the pharmaceuticals to the eye lead to better compliance rates?

In the end, rates of compliance could depend on wear modality and the disease being treated. For acute, sight-threatening diseases or painful diseases such as infections, inflammation or mechanical damage to the eye, the rates of compliance will be high, as the disease will be at the forefront of the patient's mind. In contrast, in the treatment for long-term chronic diseases such as glaucoma, compliance rates are likely to be only slightly increased compared to conventional drop therapy, as the immediacy of the disease is at the back of the patient's mind.

Comfort

Again, no studies have been published on the expected comfort or discomfort of drug-delivery lenses. Most assume that the impact on the comfort of theses drug-delivery molecules would be minimal if they were to come successfully to the market.

The challenge is to ensure that the modifications and additions to the lens materials do not negatively impact the success of the contact lens material from which it is derived. This is at the forefront of any researcher in this area who wishes to be successful.

The choice of the drug to deliver is also critical—the hope is to deliver drugs for a long period of time. It is counterproductive to attempt to deliver a drug that is known to cause adverse reactions when delivered for long periods, for example, the antibiotics gentamicin and tobramycin or the anti-viral trifluridine.

Conclusion

It is clear that contact lenses for the delivery of pharmaceuticals are an evolving discipline and an area of great interest for researchers. As the materials become more advanced and developed, the reality of commercially available contact lens devices seems to be near.

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Disclosure

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Up to 25% of herpes zoster

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Case report

History

A 37-year-old man was seen mid-week at the University of Melbourne EyeCare general clinic complaining of cloudy vision that had persisted for the previous two days in his right eye, which was similar to an episode he had experienced four months earlier.

He reported to have had his first episode of shingles four months earlier, with lesions extending onto his scalp and blurry vision in his right eye. This had been treated at the local hospital with topical steroids six times a day for three months, with the treatments tapering to cessation a month prior to his visit to the clinic. The patient was otherwise in good health without known immune compromise and was not taking any medication. He had been a full-time contact lens wearer without memorable complications and was considering returning to contact lens wear. He reported a stressful weekend prior to the recent onset of reduced vision.

Examination findings

Best corrected visual acuities were R 6/12 L 6/4.8- (NIPH – no improvement with pinhole). Pupils reacted normally with a physiological 0.5 mm anisocoria. Slitlamp examination revealed grade 1+ SPK inferiorly and significant diffuse stromal haze particularly infero-temporally (Figure 1). Four old keratic precipitates were present centrally and stromal scarring was evident infero-nasally to the visual axis (Figure 2). Lissamine green staining was negative. Intraocular pressures were 14 mmHg OU at 4:43 pm. Posterior eye examination was unremarkable with no retinal inflammation and a clear vitreous.

Diagnosis

The patient was diagnosed with herpes zoster ophthalmicus.

Differential diagnosis

Herpes simplex keratitis can present similarly but the patient's previous history was more supportive of the herpes zoster ophthalmicus diagnosis.

Management

The patient was placed on hourly Flarex to treat the haze and acyclovir five times a day for prophylaxis.

Day two review

The patient was reviewed the next day. His vision had improved to R 6/9- L 6/4.8- (NIPH). The inferior temporal cornea remained oedematous but compromise of the epithelium had increased with a small excavated area evident inferior temporally (Figure 3). This area followed the shape and orientation of the tear lake, and exhibited pooling of fluorescein in the depression without staining of the epithelium. A dellen and active epithelial disease were both considered. Underlying posterior stromal haze and oedema, suggestive of disciform keratitis and trace cells were noted in the anterior chamber.

Day two management

0.5% prednisolone minims were prescribed to replace the Flarex hourly and minimise epithelium compromise due to medication preservatives.

Day three review

At day three, the patient reported that he had been unable to obtain the minims from five different pharmacies and so had continued with hourly Flarex. Vision had improved

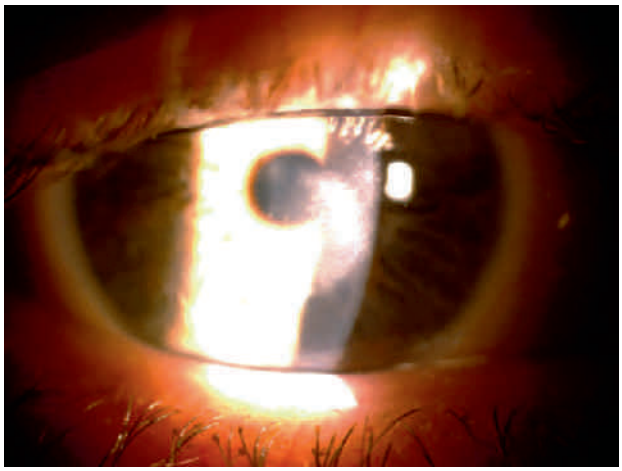

Figure 1. Cornea appearance of the right eye at day one, with diffuse stromal opacification evident infero-temporally

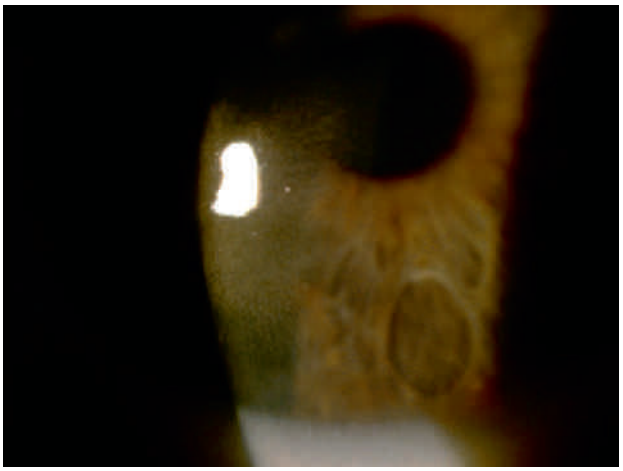

Figure 2. Cornea appearance of the right eye at day one, showing stromal scarring infero-nasally and keratic precipitates inferior to the visual axis

cases affect the eye

Desirable visual outcomes depend on quick diagnosis and treatment

to R 6/7.5- L 6/4.8-. Slitlamp examination showed that the epithelial excavation had healed and superficial punctate keratitis was significantly reduced to 2+. Corneal oedema and posterior stromal haze had reduced three-fold and the patient reported improved vision and comfort. Keratic precipitates remained.

Day five, seven, 14 and 21 reviews

The patient continued to improve at reviews on day five and day seven (Figure 4). Vision was R6/6- L 6/4.8- at day seven and acyclovir was discontinued. He reported difficulty with hourly compliance and so treatment was changed to Pred Forte two-hourly.

By two weeks, the vision improved to R+L 6/4.8-. Slitlamp examination revealed only a diminished area of central stromal haze. There was no superficial punctate keratitis, keratic precipitates or cells in the anterior chamber.

By three weeks, vision was unchanged and only trace stromal haze was evident. Pred Forte was tapered to qid with two drops before bed. The patient was to be reviewed at one month and the steroid tapered further.

Discussion

Herpes zoster ophthalmicus occurs when the varicella zoster virus, the same virus responsible for chickenpox, is reactivated in the ophthalmic branch of the trigeminal ganglion.[1] The eye is involved in 10 per cent to 25 per cent of herpes zoster cases. Of those presenting with ophthalmic involvement, 65 per cent will have corneal involvement.[2] In the general population per 100,000 there are from 30 to 60 new cases of herpes zoster ophthalmicus every year.

If treated quickly, 56 per cent of these cases result in visual outcomes of 6/6 or better.[3] Outcomes are significantly worse if the patient is immunocompromised and frequent reactivations should result in a general health work-up.

Corneal reactivation, often with triggers, causes destruction and release of viral antigens which creates inflammation. Triggers can include emotional stress, fatigue, physical illness and poor nutrition as well as any cause of immune compromise.[4]

The disease causes corneal epithelial cells to swell, which are pushed to the surface and can form corneal erosions.[5] As herpes zoster ophthalmicus damages the trigeminal nerve, corneal sensitivity is often reduced and can result in significant dry eye complications.[6] It can also cause significant pain both before the onset of other signs during the prodrome and after as post herpetic neuralgia.

Strong support for the benefit of topical acyclovir ointment in the prognosis of herpes zoster ophthalmicus is lacking.[7,8] Oral acyclovir, particularly if given within the first 72 hours, has been shown to significantly reduce viral replication, and therapeutic levels of acyclovir have also been identified in the anterior chamber with topical administration and this reportedly helps control herpes zoster ophthalmicus.[9,10]

Topical acyclovir has been shown to be highly effective in treating epithelial herpes simplex keratitis and is ideal if epithelial disease and herpes simplex cannot be excluded. Oral acyclovir can be used ongoing for prophylaxis to decrease viral replication and prevent subsequent outbreaks.[7] Although acyclovir is a relatively non-toxic drug as it is highly selective for the virus, with little effect on non-infected cells,[11] there are reports of persistent superficial punctate keratopathy[12] and this is suspected to have confounded our corneal appearance on day two. ■

References available on request from j.megahan@optometrists.asn.au. Subject: herpes zoster ophthalmicus, December 2012.

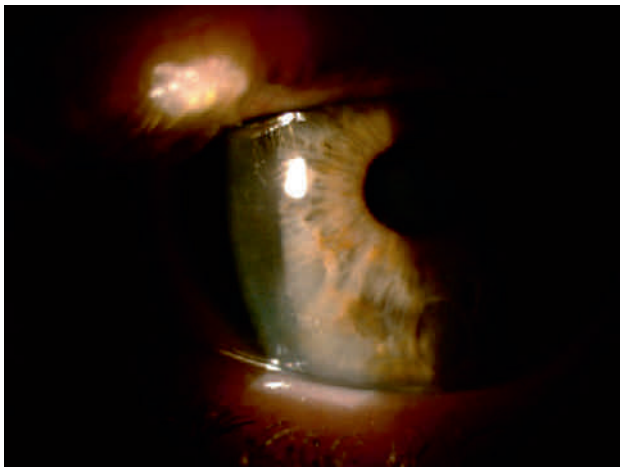

Figure 3. Compromise of corneal epithelium evident inferotemporally on day two

Figure 4. At the one week review, stromal opacification was markedly reduced and there were no signs of epithelium involvement

Chain of events *Acanthamo* in ortho

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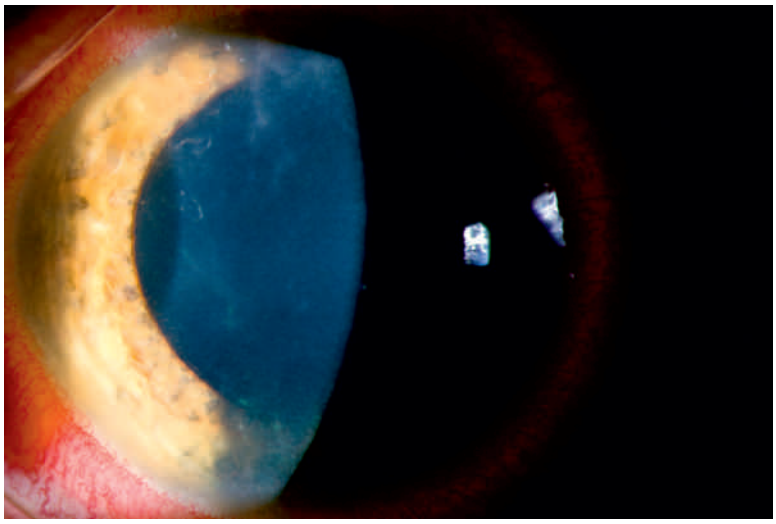

Figure 1. Initial presentation with perineural oedema and infiltates

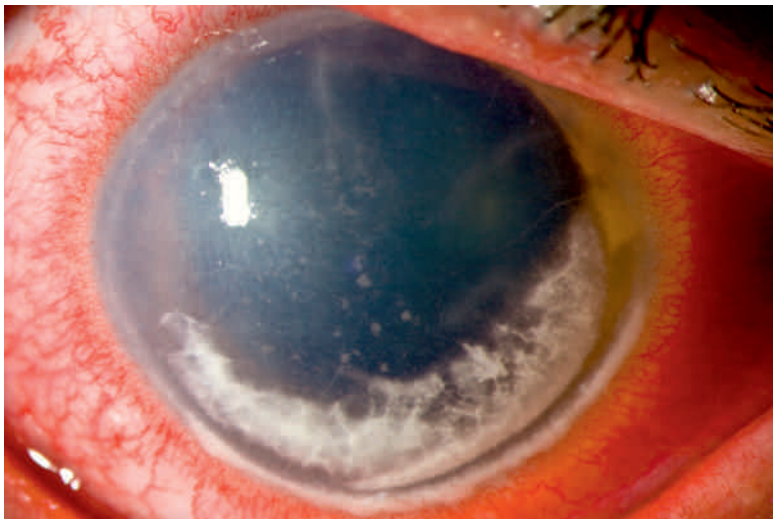

Figure 2. Results of prescribed course of therapeutics

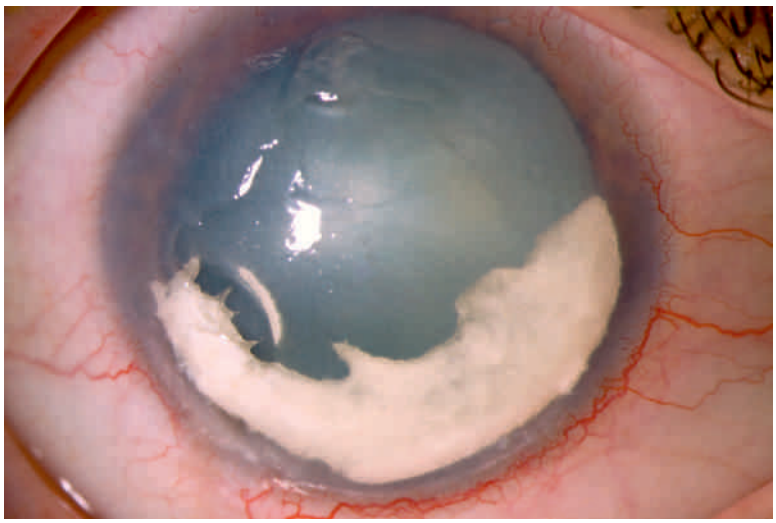

Figure 3. Inferior arcuate opacity

Case report

This case describes a 20-year-old male mild myope who has worn orthokeratology lenses for the past five years. The family optometrist referred him originally to an ortho-K practitioner whose practice later discontinued managing ortho-K, leaving the patient without follow-up and after-care for two years.

The patient initially presented to a GP with red eye and was prescribed chloramphenicol. With no improvement, the next presentation was to the family optometrist who thought a corneal abrasion was the cause of the red eye and managed the condition with a bandage contact lens. The inflammation, pain and photophobia increased, so referral was made to a local ophthalmologist who suspected *Acanthamoeba* keratitis and sent the patient immediately to the Royal Perth hospital (RPH). Between initial symptoms and diagnosis, two weeks had elapsed. Subsequently, he has been treated as both an inpatient then an outpatient since February 2012.

Figure 1 was taken at the initial presentation at RPH where a corneal scrape had confirmed the presence of *Acanthamoeba Castellani*. It shows inflammation of superior corneal nerves with oedema and white blood cells.

Figure 2 shows the results following a prescribed course of therapeutics for six weeks.

Therapeutics: PHMB, Brolene (each hourly), Ocuflox tid, Voltaren qid, Homatropine tid, Flarex bd.

The inferior arcuate opacity was thought to be either debris from drug interaction or

leads to *eba* keratitis keratology

Two years without after-care and two failed diagnoses are among factors that bring about a severely compromised cornea.

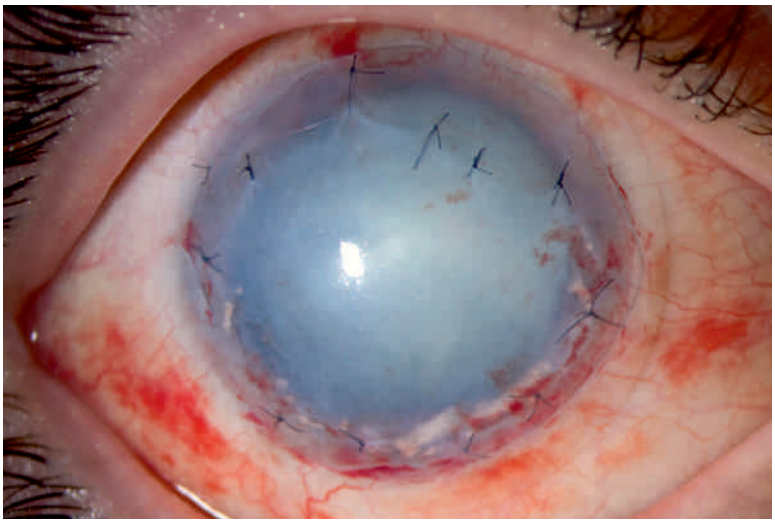

Figure 4. Results of corneal scraping

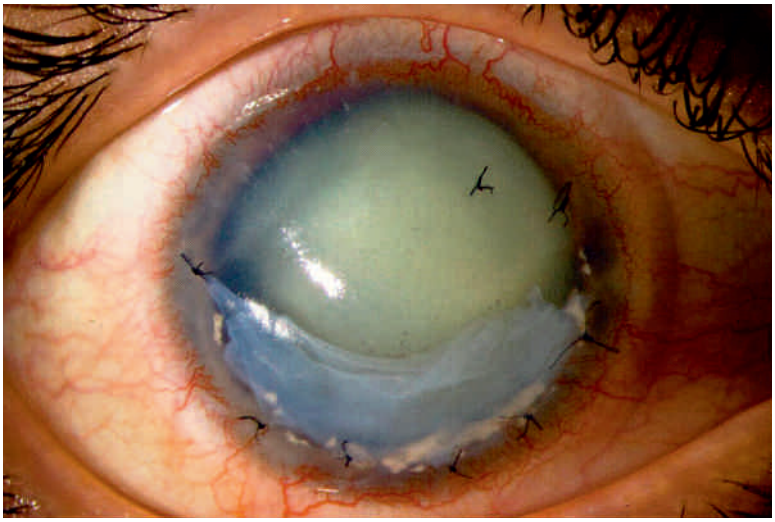

Figure 5. Resistance to re-epitheliasation

neurotrophic debris from the metabolism of the corneal surface. This opacity developed from Figure 2 to Figure 3 over three months of treatment.

Biopsies were taken in mid-April, confirming the absence of active AK but without differentiating the whitish deposits. Analysis of lenses, case and solution did not reveal active organisms. A calcium chelating agent was prescribed for the lesion but had little effect.

Figure 4 shows the result of the corneal scraping of the arc that was undertaken. Two amniotic membranes were sutured, followed by the application of a bandage contact lens to secure the cornea while the membranes took effect.

Further amniotic membrane treatment to the inferior zone was required, as a 3 mm band resisted re-epithelialisation, as shown in Figure 5. IOP spiked at 45 mmHg in mid-May because of inflammatory rather than steroid response, while therapeutics were taking effect. However, the current issue is with low IOP (<10).

This case was analysed for causative factors. The patient rinsed his lenses with tap water, then topped up his existing disinfecting solution. The lenses were then stored in the hot Perth February temperatures around 40 degrees Celsius. He inserted his lenses on to an apparently abraded epithelium and then wore his lenses overnight.

I was surprised to discover that the instruction sheet for Boston Advance Cleaner states that rinsing should be done with tap water, despite the scientific awareness that *Acanthamoeba* keratitis is ubiquitous in tap water and obviously poses a risk of infection.

This matter has been reported through Bausch and Lomb to the US Food and Drug Administration. We are awaiting a recommendation, followed by approval, of a change in the instructions for rinsing.

This is a global as well as a domestic issue, as Bausch and Lomb Australia and New Zealand discontinued Bausch and Lomb Sensitive Eyes Saline, and needs to reapply to the Therapeutic Goods Administration and the appropriate New Zealand authorities, which will take months.

Currently, this patient has poor cosmesis and this will be a concern for some time. The immediate plan is for cataract extraction with a severely compromised cornea and low IOP. The hope is that the inferior corneal structure will be able to develop to support the architecture needed before penetrating keratoplasty can be considered after nine months or so. ■

Bausch and Lomb has provided the following statement.

'While we continuously evaluate our recommendations for the Boston solution regimen, we know our products are safe and effective. Boston products have been used successfully by GP patients for nearly 35 years. Based on our patient history and our continued rigorous quality testing, we are confident in the efficacy of our products.'

Joe Barr OD MS
Vice President Global Clinical & Medical Affairs, Vision Care
Bausch + Lomb

Surgical excision of squamous cell carcinoma *in situ* lesion

Case report

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Dr Leonid Skorin Jr
OD DO MS FAAO FAOCO
Mayo Clinic Health System,
Albert Lea MN

Squamous cell carcinoma *in situ* (SCCIS), also known as Bowen's disease, was originally described by JT Bowen in 1912.[1,2] SCCIS is a slow-growing and sharply-defined lesion which is often flat and firm but occasionally has been known to be nodular or take on a verrucae appearance.[1-4] On occasion, Bowen's disease can be pigmented, which can make it difficult to differentiate from malignant melanoma without a biopsy.[5] Unlike traditional squamous cell carcinoma, in Bowen's disease the squamous cell changes are limited to the epidermis and do not penetrate into the dermal layer.[1] Because Bowen's disease affects the epidermis, it can be found on any skin that has a keratinising surface.[1] SSCIS rarely metastasises but a small number of untreated cases, from three per cent to eight per cent, have been found to progress into invasive squamous cell carcinoma.[1,3,6-8]

A 96-year-old Caucasian male presented to our office for a routine eye examination. His visual and ocular health were unremarkable. He was found to have a suspicious lesion that measured 1 cm x 1 cm on the right side of his nose. It was a raised, scaly, eroded lesion (Figure 1). It was removed with a traditional elliptical excision. The excision site was closed with interrupted sutures. The patient was instructed to use erythromycin ophthalmic ointment twice a day on the site of the sutures until his follow-up appointment. The specimen was sent to the pathology department for diagnosis. In addition, the borders were examined to ensure that complete excision had been attained.

The patient returned one week later for removal of the sutures. The excision site appeared to be healing well and no bleeding was noted (Figure 2). The sutures were removed and the patient was instructed to continue to apply erythromycin ophthalmic ointment twice a day for the following three days.

Histology slides were prepared with the hematoxylin-eosin (H&E) staining protocol. The slides showed hyperkeratosis and disorganised thickening of epidermis (Figure 3). Multiple areas of mitosis and hyperchromatic nuclei were also noted throughout the epidermis (Figure 4). Histological changes found on this specimen are typical of Bowen's disease.[1] The lesion was completely excised and the margin was 2 mm from the nearest dysplastic squamous epithelium.

Discussion

Bowen's disease is found most commonly in patients over the age of 60 years.[1,6] Causes of SSCIS have been attributed to UV light, human papillomavirus, immunosuppression and excessive exposure to arsenic.[1-3] In the Caucasian population, the lesions are found most often on the head, neck and limbs. In most cases, lesions are located on areas that are often exposed to the sun.[1,3,9] Lesion locations vary on men and women. Men are more likely to have SSCIS on the scalp, ears and neck, while women more often present with the lesions located on the lower legs or cheeks.[3,7]

In the case of a suspicious lesion, a traditional excision with wide margins is the standard method to ensure the entire lesion has been removed.[1,6] Occasionally, a Mohs' micrographic surgery (MMS) is the preferred surgical option, as it provides confirmation of complete removal of the cancer during the procedure, while reducing the amount of tissue removed.[1,10] Mohs' micrographic surgery is very useful for the higher risk areas of the eyelid and nose.[3]

While the majority of patients undergo surgical excision, there are other treatment options.[1,6,8] For some lesions, like those on the face, cosmesis and skin retention is more important to the patient. More cosmetic approaches include photodynamic therapy, 5-fluorouracil (5-FU) cream, imiquimod cream and cryotherapy.[1,7,9,11,12]

Lesions on the eyelid and eyelid margin are uncommon and have not been extensively studied.[8,9,12,13] The few case presentations or studies that do exist examine the efficacy of 5-FU cream and imiquimod cream.[8,12,13] In many cases, 5-FU cream and imiquimod cream are alternative options to customary excision due to the small amount of tissue and the complications that could arise from a traditional excision.[8,12] Possible complications secondary to excision include infection, lagophthalmos, graft/wound

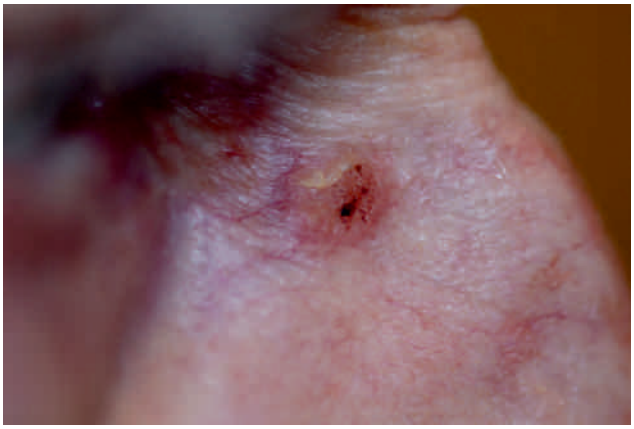

Figure 1. Raised, scaly, eroded lesion

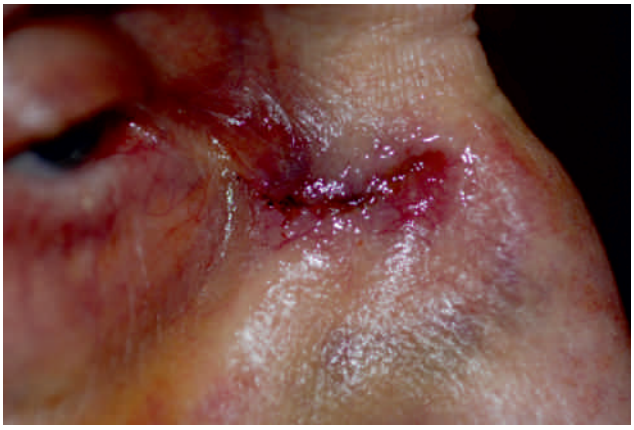

Figure 2. One week post excision

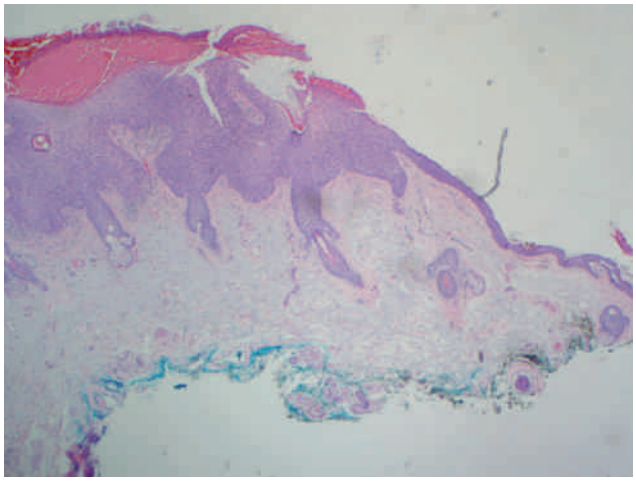

Figure 3. SSCIS hyperkeratosis and epidermal thickening on left, normal epidermis on right (H&E stain, original magnification 100X)

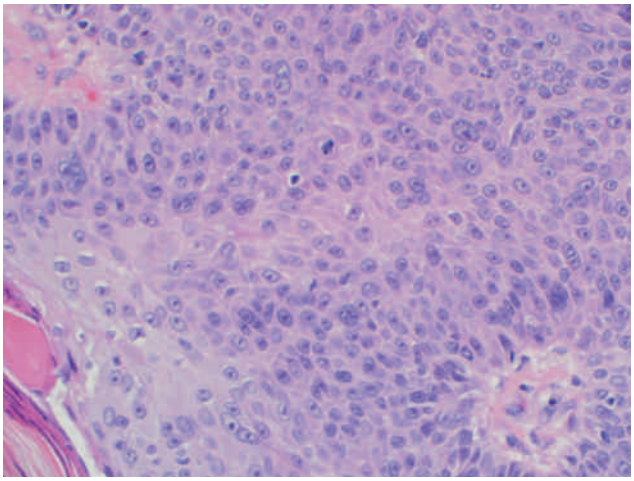

Figure 4. Hyperchromatic nuclei and mitoses throughout epidermis (H&E stain, original magnification 400X)

contraction and poor cosmesis.[8]

5-FU cream and imiquimod cream should be considered for lesions that are located on the eyelid margin. Both methods allow for the patient to administer the treatment in their own home.[8,12] For this reason, these methods should be limited to patients who have good mobility, excellent motivation and follow-up reliability.

Both 5-FU cream and imiquimod cream do have their disadvantages. Possible side-effects include erythema at the application site, conjunctivitis, *Staphylococcal* keratitis, ocular irritation, punctate epithelial erosions, preseptal cellulitis, itching, ulceration, and scarring.[3,13] Conjunctivitis and ocular irritation were the most common ocular symptoms.[13] Taking a short rest period from using the medication as well as using artificial tears can help to alleviate most of the ocular side-effects. In all cases, the side-effects had completely cleared up shortly after the resolution of the treatment.[13]

At this point, there is no complete agreement on treatment for SSCIS.[3,7] Treatment options are selected based on multiple factors. Doctors will often consider the size and location of the lesion. In addition, cost and efficacy of each type of treatment should be considered, as all treatments do not have the same cure rate.[3] While there is no consensus on treatment for Bowen's disease, it should be noted that various studies have shown MMS and elliptical excision to have the lowest recurrence rates of all treatment options.[3,7] In a few rare cases, SSCIS has been known to spontaneously regress but this is an uncommon occurance.[6]

Conclusion

In an increasing elderly population, the eye-care professional is likely to come across suspicious skin lesions regularly. Bowen's disease is a fairly common cancerous lesion that needs to be differentiated from severe and invasive cancers. Differential diagnoses include eczema, superficial basal cell carcinoma, psoriasis, actinic keratosis, and traditional squamous cell carcinoma.[1,8,12] Regardless of aetiology, any cancerous or pre-cancerous lesion needs to be treated. Treatment options range from simple excision to topical ointment. Treatment possibilities should be discussed with the patient so both the patient and the doctor can come to a conclusion on the best treatment method to use. ■

References available on request from j.megahan@optometrists.asn.au. Subject: Carcinoma in situ, December 2012.

Pan-retinal photocoagulation for diabetic retinopathy reduces retinal nerve fibre layer thickness

Peripapillary retinal nerve fibre layer (RNFL) thickness has been shown to be decreased, relative to baseline, 24 months post pan-retinal photocoagulation (PRP) in diabetic retinopathy patients.

A prospective study examined longitudinal changes in RNFL thickness in 31 eyes (25 patients) that required PRP due to either severe non-proliferative diabetic retinopathy or non-high-risk proliferative retinopathy. Optical coherence tomography was conducted prior to PRP and at three, six, 12 and 24 months following PRP.

At 24 months follow-up, superior, nasal, inferior and mean peripapillary RNFL thickness was significantly reduced compared with baseline. Interestingly, temporal RNFL thickness was significantly increased.

It was concluded that, in addition to diabetes itself and diabetic retinopathy, PRP may be a cause of RNFL thickness loss in patients with diabetes.

Retina 2012; Sep 17 (Epub ahead of print).

Effect of topographic cone location on outcomes of corneal collagen cross-linking

Following corneal collagen cross linking (CXL), greater topographic flattening has been shown to occur in eyes with centrally-located cones than peripherally-located cones. This effect was observed both in eyes with keratoconus and corneal ectasia.

In this prospective, randomised, controlled clinical trial involving 99 eyes (66 keratoconus, 33 ectasia), cone location was defined by the co-ordinates of the preoperative maximum keratometry (K) value as variously: central (within the central 3 mm), paracentral (within the 3-5 mm optic zone) or peripheral (beyond the 5 mm optic zone).

One-year post-CXL, maximum K decreased by 2.60 ± 4.50 D ($p < 0.001$) in the central cone group, 1.10 ± 2.50 D ($p < 0.05$) in the paracentral cone group and 0.40 ± 1.20 D ($p > .08$) in the peripheral cone group. Differences among groups were all statistically significant ($p < 0.001$). Changes to uncorrected vision and best-corrected visual acuities were not significantly different between groups.

Given these findings, the effect of preoperative cone location on other CXL outcomes was reported to be the focus for future study.

Greenstein et al. *J Refract Surg* 2012; June 28: 6: 397-405.

Abstracts

Dr Laura Downie
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Co-existence of macro- and micro-vascular abnormalities in newly-diagnosed normal tension glaucoma patients

It has been demonstrated that early stage, newly-diagnosed normal tension glaucoma (NTG) patients have signs of subclinical vascular abnormalities at both macro- and micro-vascular levels.

The study involved the comparison of newly-diagnosed and previously untreated NTG patients (n = 19) and age-matched controls (n = 28). Subjects underwent the following assessments: retinal vascular reactivity to flickering light (dynamic retinal vessel analysis), measurement of carotid intima-media thickness (IMT), pulse wave analysis, blood pressure and blood analyses for lipid metabolism markers.

Compared with controls, NTG patients demonstrated a significantly increased right and left IMT. They also showed an enhanced arterial constriction response, a steeper arterial constriction slope and a reduced venous dilation response following flicker light stimulation ($p < 0.05$).

The authors indicated that these findings highlight the need to consider multi-level circulation-regulated pathologies in the development and progression of NTG.

Acta Ophthalmol 2012; Sep 23 (Epub ahead of print).

Low humidity negatively affects tear film quality

Exposure to a low relative humidity environment has been found to adversely affect tear film physiology.

A controlled environment chamber was used to create two different environmental conditions. Ambient temperature was held constant (21 degrees Celsius) while the relative humidity (RH) was set at 40 per cent (normal condition) or five per cent (dry environment). Tear evaporation, non-invasive tear break-up time (NITBUT), lipid layer thickness (LLT), osmolarity, tear production and ocular surface temperature were assessed in normal humidity and over a period up to 60 minutes in the dry environment.

The dry environment caused significant, adverse changes to tear evaporation rate, NITBUT, LLT, ocular comfort and tear production; osmolarity and ocular surface temperature were not significantly altered.

The authors noted that exposure to a desiccating environment for one hour induced changes to tear film parameters similar to those induced by dry eye disease. It was suggested that to avoid tear film disruption and potential ocular surface damage, measures should be taken to minimise the adverse environmental effects of dry locations on the tear film.

Abusharha AA, Pearce EI. *Cornea* 2012; Sep 27 (Epub ahead of print).

Pupil diameter affects axial growth changes in myopic children undergoing orthokeratology

Larger scotopic pupil diameters have been found to be associated with reduced axial elongation in children undergoing orthokeratology (OK).

Chinese children (n = 52) aged 9-14 years were assigned to either OK (n = 27) or single-vision spectacles (SVL, n = 25). Subjects in each group were stratified according to baseline pupil diameter. Axial length was measured at baseline and every six months for 24 months.

Axial growth was significantly slower in children with above-average pupil sizes ($p < 0.001$) in the OK group compared with all other treatment groups. Pupil size did not affect axial length changes in the SVL group.

The authors concluded that larger pupils may facilitate the effect of OK to slow axial growth in myopic children.

Chen et al. *Optom Vis Sci* 2012; Sep 28 (Epub ahead of print).

Timolol affects refractive outcomes in eyes with myopic regression after LASIK

Timolol 0.5% eye-drops have been found to be effective for the treatment of myopic regression after laser *in situ* keratomileusis (LASIK).

This prospective, randomised, parallel-controlled, double-masked clinical trial evaluated the effect of timolol 0.5% eye-drops compared with artificial tears (control) on myopic regression following LASIK surgery. Forty-five eyes were analysed per group over six months. The primary outcome measure was the change in spherical equivalent (SE).

In timolol-treated eyes, the SE improved from -1.48 ± 0.99 D before treatment to

Clinical QUIZ

ANSWER

From page 7

Diagnosis

The absence of anterior chamber involvement ruled out uveitis. The patient did not complain of any aches or pains and blanching of blood vessels ruled out scleritis. The patient had not been ill recently and did not have any follicles or papillaes.

FP was diagnosed as having diffuse episcleritis.

Treatment, including drugs, dosages and review

FP was given Flarex eye-drops and asked to instill them every two hours for the first day and return to be reviewed in 24 hours.

There was no change the next day. He was asked to continue with Flarex qid for 4/7. The patient showed very slow improvement and was asked to continue with the eye-drops and was monitored weekly.

After two weeks, the patient still had grade 1.5 hyperaemia diffusely and grade 2 hyperaemia with chemosis superiorly. Because of the slow improvement, FP was switched to Predforte qid and reviewed weekly.

The review the following week revealed grade 2 hyperaemia superiorly with a central nodule. The conjunctiva was clear elsewhere. FP was to continue with the Predforte qid and reviewed in one week.

Given that the conjunctiva was now white and quiet in appearance, taper of the steroid was initiated. The nodule had not changed much in size.

At the visit the following week, FP was started on Ibuprofen 2 tablets qid for one week to try and decrease the size of the nodule.

At the visit the following week, the nodule had flattened completely. The patient was asked to taper off the Ibuprofen.

Comments

Given the severity of the episcleritis, it was suggested that he should have a systemic work-up with his GP. The patient was also warned about the possibility of recurrence. ■

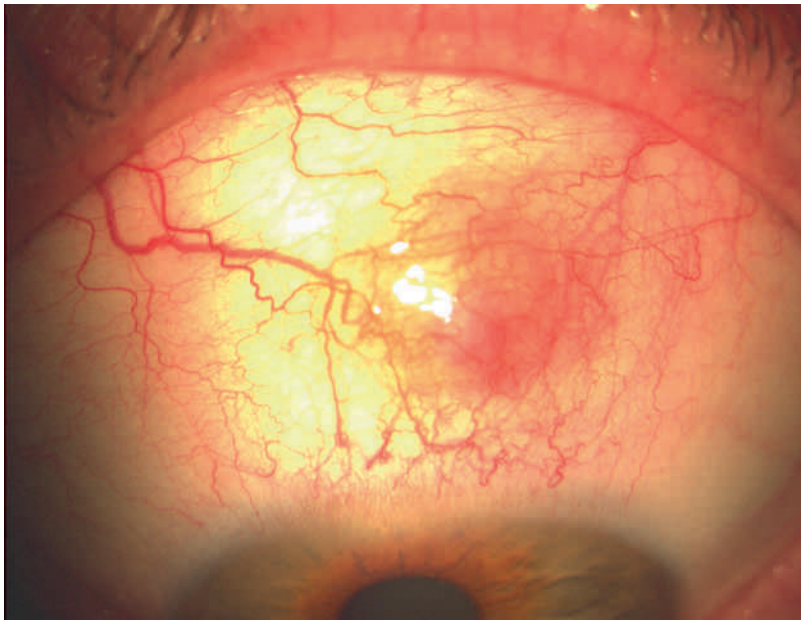

Figure 2. Week four, decreased hyperemia allowed visualisation of raised nodule

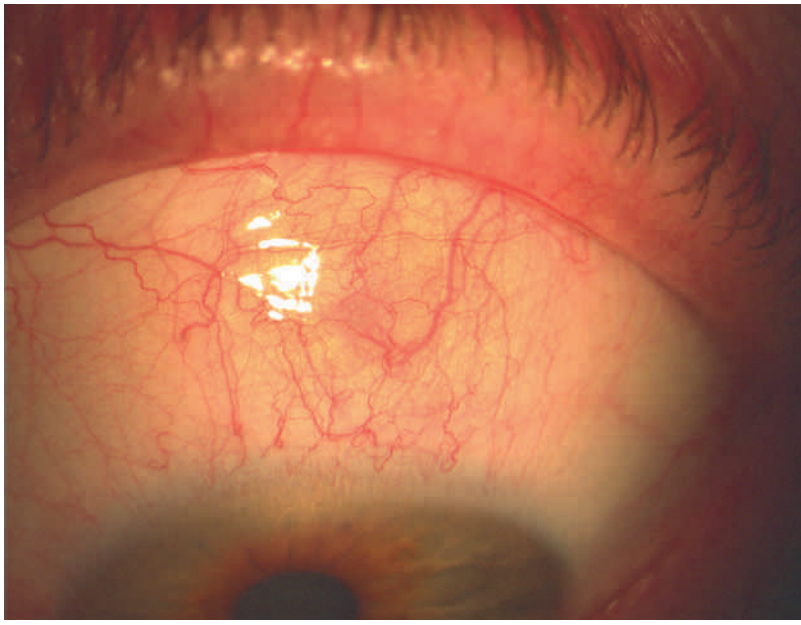

Figure 3. Week seven, flattening of the nodule

-0.88 ± 0.91 D six months after treatment; six months after discontinuation of timolol the SE was -0.86 ± 0.93 ($p < 0.001$). In controls, the SE changed from -1.57 ± 0.67 D before treatment to -1.83 ± 0.76 D six months after treatment; six months after discontinuation of the eye-drops the SE was -1.91 ± 0.70 D ($p < 0.001$).

The application of timolol reduced post-LASIK myopic progression. This effect was shown to persist for at least six months after its discontinuation.

Shojaei et al. *Am J Ophthalmol* 2012; Aug 28 (Epub ahead of print).

Penetrating keratoplasty versus deep anterior lamellar keratoplasty: comparison of optical and visual quality outcomes

A prospective, randomised case series involving 174 eyes of 140 consecutive patients with moderate to advanced keratoconus evaluated and compared the visual and optical performance outcomes in patients who had deep anterior lamellar keratoplasty (DALK) (n = 99) versus penetrating keratoplasty (PK) (n = 75).

Post-operative best-corrected visual acuities were 20/40 or better in 64 eyes (85 per cent) in the PK group and 82 eyes (83 per cent) in the DALK group ($p > 0.05$). There were also no significant differences between the two groups for mean spherical equivalent and maximum keratometry values, photopic contrast sensitivity or aberrometry.

The authors concluded that DALK is an alternative treatment option in eyes with moderate to advanced keratoconus, providing comparable results to PK in terms of visual acuity, refraction, contrast sensitivity and high-order aberrations.

San et al. *Br J Ophthalmol* 2012; 96: 1063-1067. ■

Use of fluorescein in specialty hard lens fitting

Dr Gavin Boneham
BSc BOptom PhD

The first reported use of fluorescein sodium, conventionally known as fluorescein, was in 1882, by Pflüger, who stained the cornea and conjunctiva of rabbits. In standard optometric practice, it is commonly used to assess corneal integrity, locate damage to the cornea and conjunctiva and measure tear break up time. In the world of GP lens fitting, fluorescein is integral in assessing contact lens fitting. Mini-scleral lenses and orthokeratology (OK) are a growing subset of RGP lenses. These two modalities both employ fluorescein to ensure an optimal contact lens fit.

Mini-sclerals

This group of lenses varies in size from 13.5 mm (corneosclerals) to 18 mm. They are large and require proper fitting to ensure optimal health for the cornea. When correctly fitted, they provide comfortable wear for all waking hours.

Mini-sclerals are sealed, with the space between the back of the lens and the corneal surface filled with saline. An optimal fit will have the central depth of the post-lens tear film, no more than 300 microns deep and no touch at the limbus. These measurements can be made using a slitlamp and placing fluorescein into the saline pool. To assess central tear film thickness, using an optic section, you compare the depth of the post-lens tear film with the central lens thickness (normally around 300 microns) and make adjustments from there (Figure 1). Another approximate test is that the saline pool is about the correct depth if, when using the blue light, you can just see the pupil (Figure 2).

When fitting large diameter lenses, there should be no contact with the limbus, the important source of stem cells for the corneal epithelium. An optimally-fitted mini-scleral should have a limbal glow of fluorescein (Figure 2).

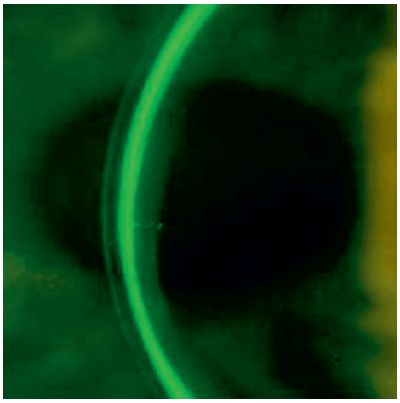

Figure 1. Using an optic section, the fluid depth between the lens and the cornea can be seen. The central thickness of the lens is 300 microns. At the thinnest point, the tear film is approximately 200 microns.

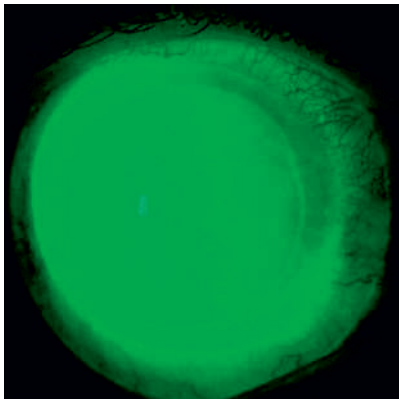

Figure 2. A well-fitting mini-scleral lens. The pupil is just visible through the fluorescein. A limbal 'glow' of fluorescein can be seen.

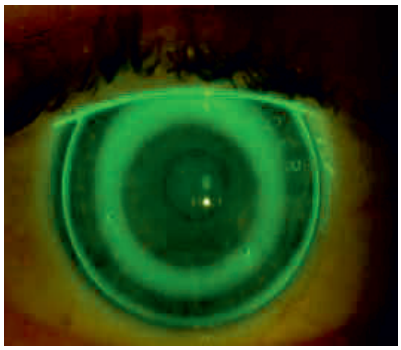

Figure 3. A well-fitted orthokeratology lens. Central dark area of no fluorescence in the treatment area, surrounded by a 'moat' of fluorescence. Outside of this is another dark area, the landing zone.

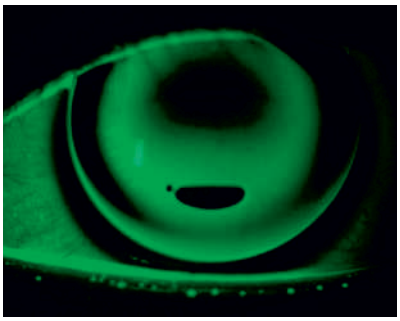

Figure 4. A traditional, spherical CRT lens is fitted onto an astigmatic cornea. Fluorescein can be seen to be 'leaking' especially inferiorly into the landing zone area. Fitting with a dual axis CRT lens 'fixes the leak'.
Photo: Patrick Caroline FAAO

Orthokeratology

In OK, fluorescein is not generally used to determine fit–the corneal topographer is the crucial tool here–but fluorescein is still necessary, apart from checking for staining. The classic shot of an OK lens fitting shows a central dark area surrounded by a 'moat' of fluorescence (Figure 3). To the untrained eye, this central dark area would represent touch between the cornea and the back surface of the lens, but in OK there should always be a space between the lens and the cornea, which is filled with tears. Why does this space not fluoresce? This is because the tear lens thickness needed for fluorescein to be seen is 10 to 20 microns. In most cases, the tear film thickness in the treatment area is less than 10 microns.

Astigmatism and orthokeratology

The shape changing effect that occurs in OK is due to the relative entrapment of the tears in the central and reverse curve areas of the lens, which allows the tears to apply the pressure needed to change the corneal shape. Any 'leaks' in that system will result in the lens not working as well as it should. Leaks mainly occur in so-called 'limbus to limbus astigmatism'. Fluorescein can identify these leaks and inform the practitioner to fit an astigmatic OK lens. ■

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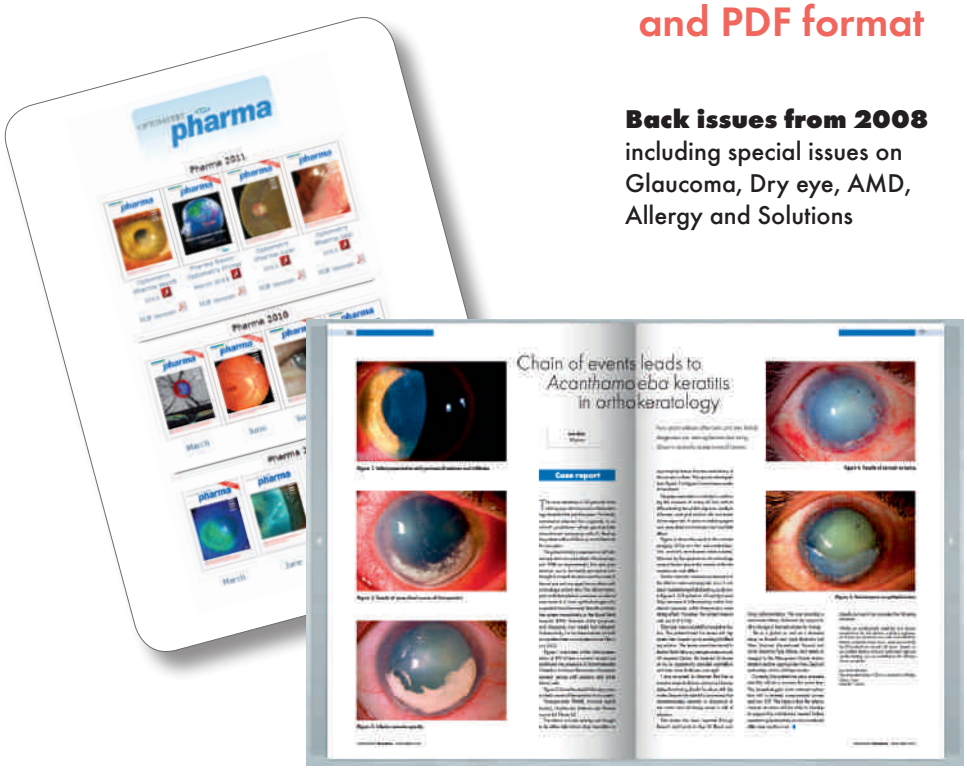

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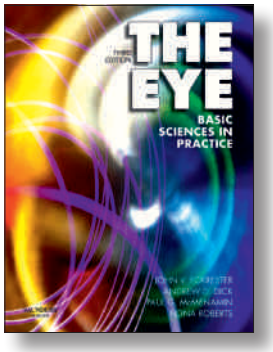

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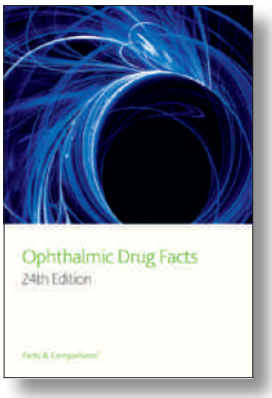

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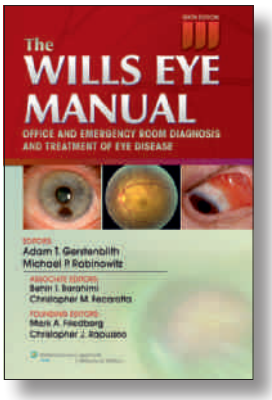

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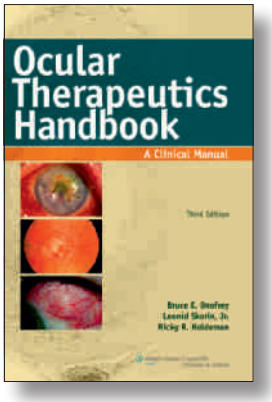

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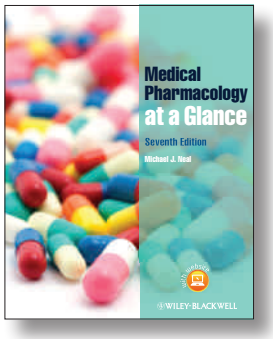

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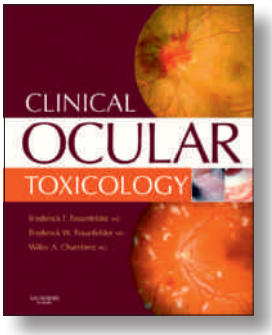

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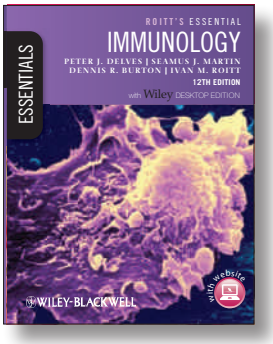

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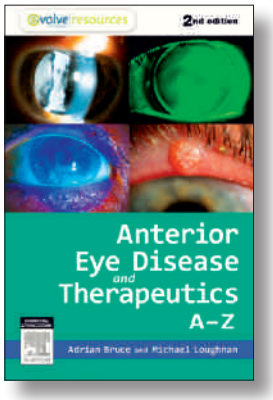

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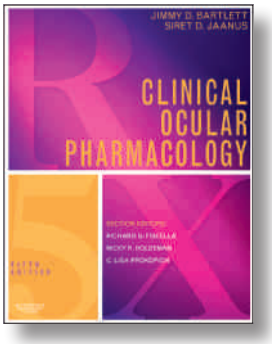

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