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Abstracts

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Monovision: is binocularity worth the bother or should we let dominance dominate?

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Monovision usually works well: studies suggest a success rate of about 50–70%. Yet, recent studies show that good binocularity confers a greater advantage on an individual than had previously been believed. Since monovision essentially sacrifices good binocularity, these two findings seem to be paradoxical. This lecture will address this apparent paradox since its resolution may help us to understand why some patients adapt well to monovision and others do not. The common advice when prescribing monovision is to give the distance vision lens to the dominant eye. Yet, research on ocular dominance reveals that the eye which appears to be dominant depends on the method of testing. There are three main types of ocular dominance: sighting, sensory, and motor. There are several different tests within each of these categories, all of which may give conflicting results in a given patient. Research on which test of ocular dominance is most relevant when prescribing monovision will be discussed. Monovision, like most healthcare interventions, is associated with some adverse effects. Practitioners must be aware of these, not least because of possible medico-legal implications. The main adverse effects of monovision can be summarised as monocular blur and impaired stereopsis, and a third possibility is the decompensation of a pre-existing binocular vision anomaly. The monocular blur can be apparent at night as glare or haloes and occasionally may cause difficulties during daytime vision, for example, if the distance eye's view is obscured. Patients with monovision only very rarely report impaired stereopsis as a symptom, possibly because monocular clues to depth perception take over from binocular stereopsis. Cases of decompensation of binocular vision after monovision seem to be extremely rare, but it is suggested that patients should undergo a careful assessment of binocular function before monovision is attempted.

The effects of ageing on accommodation function

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Various features of the accommodation mechanism change with ageing and most of them seem to conspire to reduce accommodation activity. It is well established that the elasticity of the lens capsule declines throughout life whilst the lens' capacity to be deformed increases with ageing. These two factors are major causes of presbyopia. Meanwhile, ciliary muscle power does not decline with ageing and may in fact increase. However, morphological changes in the arrangement of the ciliary muscle in relation to the lens equator and the zonule may mean that the ciliary muscle loses its effectiveness in accommodation with ageing even though its strength remains vigorous. In this presentation, these aspects of the processes of presbyopia will be reviewed and some consideration given to their effects on accommodation function and the needs of clear near vision.

Seven years experience with silicone-hydrogels

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Purpose: To consider clinical experience with usage of silicone-hydrogel materials over 7 years, and discuss contemporary issues such as radical refraction changes, new materials and new designs.

Method: We have been using silicone-hydrogel materials for some 7 years and have continuing patients in various wearing schedules including daily wear and 30-day extended wear mode. This paper will highlight the clinical signs and symptoms from these patients, analyse problems with products and look at emerging trends in the field.

Results: Ongoing patients report high satisfaction rates with the convenience and comfort of silicone-hydrogels. Many patients enjoy the benefits extended wear offers and, having been warned of the potential complications of the modality, choose flexible wearing patterns. The absence of

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ocular changes and signs such as microcysts, limbal injection and endothelial irregularity in ongoing patients is an outstanding feature with these lenses. The more significant problems confronting the practitioner include the incidence of papillary conjunctivitis, management of corneal infiltrative events and hyperopic refractive shifts in higher powered lenses where the lens modulus is high. New materials and designs in the silicone-hydrogel realm, such as uncoated materials for daily wear and toric lenses, demonstrate excellent clinical performance.

Conclusions: With careful patient selection and instruction, continuous wear of silicone hydrogels provides a convenient, comfortable and long-lasting refractive solution for many patients. Continued practitioner education and vigilance is necessary to ensure the further success and development of the modality.

Progressive power lenses

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The form of surface which will connect spherical distance (DP) and near portion (NP) curves to provide a progressive surface can be derived from the Davis–Fernald formula for the variation in tangential power of a surface. The resulting surface astigmatism can be eliminated along the meridian line by varying the sagittal curvature during CNC machining of the surface. It is, essentially, the sagittal curves in the progression which differentiates the various makes of progressive lenses. In order to obtain wide aberration-free distance and near zones, the blending of the DP and NP surfaces must take place only in the progression zone. This produces rapid changes in power and astigmatism between the zones and results in a hard design. Allowing the change in power and astigmatism to take place more slowly over a larger area of the lens results in narrower aberration-free zones that have proved more acceptable to wearers. Such designs have been described as soft and generally have longer progression zones than surfaces of hard design. Adaptation to progressive lenses takes place in the visual cortex and the mechanism is by no means properly understood. However, practice clearly indicates that in the early stages of presbyopia, when the addition is low, multifocal lens wearers adapt easily to progressive lens correction as much to bifocal correction. As the addition increases, the advantage of having a correction for all distances outweighs any optical drawbacks of progressive lenses. A recent addition to the range available is the occupational progressive lens designed for the correction of intermediate and near vision. The change in power between the near and intermediate zones is often referred to as the degression power and is less than the full addition between distance and near. This feature, and a long progression zone, provides a wide aberration-free corridor.

Contact lens complications in the 21st century

Nathan Efron

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Over the past 30–40 years, there has been an immense amount of scientific literature describing changes that occur in the ocular structures during contact lens wear. As we enter the new millennium—with a host of new and sophisticated lens designs and materials, lens wearing modalities and care systems, and access to exciting new ways of examining the cornea—we need to radically rethink our understanding of contact lens complications. Many complications are becoming more important, and others are becoming less relevant. Now that the pathophysiological basis of most complications is well understood, more efficacious strategies can be employed to deal with those complications that do require active management. Although many of these changes are asymptomatic, they can still pose a threat to ocular health and visual integrity. It is now possible in almost every case to avoid serious complications by making careful initial observations and taking appropriate action. The scientific and clinical basis for this 21st century approach to contact complications will be outlined, and specific examples will be highlighted.

Oxygen revisited: is there a better way than Dk?

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This lecture presents an overview of respiration on the human body and considers the special case of the cornea. The history of the development of criteria for determining the critical oxygen availability to the cornea to sustain normal corneal respiration is reviewed, and the notion that lens oxygen transmissibility evaluation is the best methodology is challenged in favour of a consideration of corneal oxygen flux.

What happens to keratocytes during continuous contact lens wear?

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Keratocytes play a key role in maintaining the structure and transparency of the cornea as they are the source of stromal collagen and proteoglycans. Thus, clinicians would be concerned if any form of disease or clinical intervention threatened the integrity of keratocytes. The relatively recent development of the corneal confocal microscope has provided researchers and clinicians with the opportunity of observing the living human cornea at up to 680× magnification (bearing in mind that the maximum possible magnification with a slit lamp biomicroscope is 40×). Keratocytes can be clearly observed, and researchers have begun to examine the

effects of contact lens wear on keratocyte populations using this instrument. A furious controversy has quickly emerged, whereby the research community is divided as to whether contact lens wear causes a reduction in the keratocyte population. A possible confounding factor in this research is the role of lens-induced oedema creating an optical artefact that gives the false impression of keratocyte loss. This lecture will briefly review the current literature and will describe a series of confocal microscopy experiments that have sought to clarify the question of keratocyte loss associated with contact lens wear. It is demonstrated that contact lens wear does indeed cause a loss of keratocytes, and that this phenomenon is unrelated to lens-induced hypoxia or oedema. Etiological factors may include physical irritation of the epithelium causing a release of cytokines resulting in keratocyte death and retardation of epithelial desquamation. A possible clinical correlate of lens-induced keratocyte loss is stromal thinning as seen in long-term extended contact lens wear.

The art of GP bifocal contact lens fitting

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As an alternative to glasses, several presbyopic correction options are available to our patients. Of all the options available, GP lenses offer the best optical outcome. Refractive surgery and hydrogel contact lens wear have not been able to provide the same level of visual satisfaction.

There are numerous lens designs available within the GP presbyopic lens group, which may appear challenging and confusing to practitioners. However, fitting presbyopic patients with GP lenses is less difficult than it appears. Despite the fact that there are numerous systems available, they can all be categorised into a limited number of basic designs. If single vision lenses (under- or overcorrection or monovision) are not the preferred solution, there are only two main presbyopic options left: simultaneous vision and alternating vision.

The amount of time spent behind a computer and other work/leisure-related activities, corneal shape as assessed by topography, degree and shape of astigmatism, degree of eccentricity, previous lens wear, lens fit, comfort of wear, hypoxia, contrast sensitivity, pupil size, eyelid shape, fissure size, blink rate, lens movement, tear film characteristics, anterior chamber depth, depth perception, and the prescription itself all play a part in the choice and in the success of this modality.

Different simultaneous designs are available, all offering a true multifocal system making it suitable for patients with intermediate distance demands, especially those doing computer work. Among many others, optical quality and the influence of the lens on the corneal surface are the main reasons for choosing one design over the other. If high near power is required, these lenses may not give the desired visual outcome.

The many visual limitations that arise with hydrogel lens wear are overcome with GP lenses, especially when using alternating designs. Alternating designs vary in size and shape, but they all aim to provide good alternating single vision far and near. However, some of the currently available lens systems partially function as a simultaneous system as well. The reading add is usually unlimited, which gives the best outcome in people with high reading demands.

Combinations of the above systems are often possible and desirable, leading to a high success rate of bifocal GP lens fitting in practices that are willing to invest in this technology.

Corneal topography—a necessity in fitting contact lenses

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Corneal topography has proven to be useful in everyday practice. It is also essential for new developments in the eye care field such as orthokeratology and refractive surgery. In this presentation, the sense and non-sense of the use of corneal topography will be covered, with special attention on the many new developments in this field.

To define the shape of the cornea, simple spheres and ellipses are not sufficient. Complex mathematical formulas are needed, such as Zernike polynomials, to describe that shape, which can be done with a fairly high level of accuracy today.

However, one should bear in mind that the cornea remains human tissue, which can be altered and influenced in many ways. Age, but, for instance, accommodation as well, seems to influence the topography of the corneal surface. In addition, modern corneal topographers have their limitations when reproducing the shape of the cornea. Different types of corneal topographers are available today and their limitations will be discussed.

What information is clinically relevant when fitting contact lenses? A good estimation of the corneal astigmatism and whether this is located centrally or peripherally, for instance is. Based on the information about corneal shape, lenses can be fit that respect the shape of the cornea better, which can increase comfort of wear. Currently, several new lens designs are available serving to achieve this goal. Bi-aspheric lenses (two meridians with different eccentricity) for instance serve to respect the shape of the cornea better in low and peripheral corneal astigmatism. Furthermore: quadrant specific lenses are commercially available now to serve the special needs of the cornea better. But this is only the beginning: custom made lenses based on cornea topography will change the future of GP lens fitting.

Optical performance is one of the major advantages of GP lens wear, but improvement is always welcome, and may

be desirable. The possibilities and limitations of wavefront corrected GP lenses will be discussed.

Getting back to vision

Arthur Ho

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Breakthroughs in optical measurements and manufacturing technology has made possible contact lenses which could correct more than just sphere and cylinders. We are now seeing aberration-corrected/controlled designed contact lenses becoming available. So, how far could we go with this technology?

To attempt to answer this question, we will review the research outcome from around the world in the area of aberration measurements and correction.

The future is near: up-coming treatments for presbyopia and restoring accommodation

Arthur Ho

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This presentation details the current developments aimed at restoring accommodation to the presbyope. The predicted performance, benefits (and drawbacks) of strategies ranging from pseudo-accommodation devices to phaco-ersatz techniques will be discussed.

Topics covered include:

(I) Disadvantages associated with convention presbyopia corrections.
(II) Surgical strategies for presbyopia:
  (a) Pseudo-accommodating and accommodating devices.
  (b) Phaco-ersatz and related surgical approaches.

Soft contact lens materials and manufacture

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Hydrogel materials are highly sensitive to the processing and fabrication conditions to which they are subjected. This is likely, therefore, to be a relevant consideration in the production of hydrogel ('soft') lenses since these lenses are currently manufactured by different methods. The most widely used methods are lathe-cutting, spin-casting and cast-moulding. Lenses made by these different methods of manufacture will undergo very different material processing—particularly polymerisation. These different material processing steps may have an effect on the resultant lens—from its clinical performance (e.g. lens centration and movement) to its physical and chemical characteristics (e.g. lens surface wettability and mechanical properties).

The decision as to which technology should be used to manufacture a particular lens is based on factors such as wear modality, clinical use, ease of manufacture (material and design) and commercial considerations. However, key factors which are affected by different manufacturing technologies such as surface chemistry and bulk material physical properties have not been directly compared. Furthermore, the clinical benefits of these manufacturing processes have not been evaluated.

Notwithstanding a considerable body of scientific evidence that has defined the clinical performance and physico-chemical properties of soft lenses, there has been little attempt to establish a relationship between these two fundamental descriptors of contact lens performance as they relate to the different methods of lens manufacture.

This lecture will provide an overview of the history and development of soft contact lens materials and manufacture with particular emphasis on the different processing steps involved and how these steps might affect the final lens. Experimental results investigating the impact of manufacturing processes on various characteristics of soft lenses will be presented together with how these are related to their clinical performance on-eye.

Mechanisms of accommodation and presbyopia

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Surgical procedures are increasingly being employed to provide optical compensation for presbyopia. These include corneal refractive surgery and the use of bifocal, diffractive or multifocal intraocular lenses. In addition to these more traditional surgical interventions a number of controversial experimental surgical procedures have become available which are said to reverse the effects of presbyopia through the restoration of accommodation. These so-called scleral expansion procedures include radial ciliary sclerotomy and surgical implantation of scleral expansion bands. The theoretical basis for these surgical procedures flies in the face of current understanding of the accommodative mechanism and the causes of presbyopia and inadequate clinical testing of these patients leaves considerable doubt as the efficacy or possible beneficial consequences of these highly experimental surgical procedures. An overview of the anatomy of the accommodative apparatus of the eye will be presented. The classical Helmholtz accommodative mechanism will be detailed with videographic evidence from ongoing studies on rhesus monkeys. This will be followed by a overview of factors contributing to the development of presbyopia that are supported by experimental evidence from studies of human eye-bank eyes and non-human primates. This includes

evidence for lenticular factors such as hardening or sclerosis of the lens as well as extralenticular factors such as loss of choroidal elasticity with increasing age. The relevance of the scientific data addressing the causes of presbyopia will be put into the context of approaches aimed at restoring accommodation in presbyopes. The scleral expansion surgical procedures will be described and the theoretical basis of scleral expansion surgery to restore accommodation will be presented and critiqued in light of experimental evidence against them. The future prospects of surgical interventions aimed at restoring accommodation will be considered with reference to ongoing experimental work on the surgical reintroduction of accommodative intraocular lenses.

Optical and cortical mechanisms for simultaneous vision multifocals

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Simultaneous vision multifocals are unique among ophthalmic presbyopic corrections in that their optical effects are present for all gaze positions. However, because of their optical structure, their performance is generally more susceptible to variation in pupil size. Lens designers have put considerable emphasis on minimising (e.g. "pupil independent", Echelon) or exploiting (e.g. "pupil intelligent", Acuvue) this relationship. Nevertheless, these design strategies produce a retinal image for all viewing distances that is only partially in focus. Numerous researchers have documented the resulting contrast reduction and, in certain cases, secondary images ("ghosting"). Recent advances in technology for measuring and analysing monochromatic aberrations of the human eye have permitted us to better understand how simultaneous vision lenses work or fail to work. These analyses show that the "add effects" for most of these designs are directly related to the amount of spherical aberration present in the eye/lens combination. Conversely, the overall quality of vision is inversely related to this combination. Aberrations generally associated with decentred optics (e.g. coma) tend to be higher with simultaneous vision lenses than with single vision lenses. It is also useful to compare the visual performance of simultaneous vision lenses to that of another ophthalmic strategy possessing benefits of gaze independence, monovision. Simultaneous vision provides better performance than monovision in many functions requiring binocular inputs (e.g. fusional ranges, stereopsis). Conversely, interocular suppression of blur requires a well-focused image in one eye, a condition that is best achieved with monovision. Nevertheless, there is evidence that patients can learn to interpret and cope with degraded images. Their willingness to accept these compromises is strongly influenced by habitual vision demands and to a smaller degree by certain psychological characteristics. This information is useful in presbyopic patient and method selection.

Grading of corneal transparency in contact lens practice

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Purpose: To examine the academic literature regarding corneal transparency grading and to assess the potential use of objective image analysis in clinical contact lens practice.

Method: Reference databases of academic literature were searched and relevant articles reviewed. Annunziato, Efron (Millennium Edition) and Vistakon-Synoptik corneal oedema grading scale images were analysed for relative intensity, edges detected, variation in intensity and maximum intensity. The recovery from corneal oedema (induced using a thick hydrogel contact lens worn for 3 h on a patched closed eye) was monitored by image analysis of the corneal optic section and compared to ultrasound pachymetry, visual acuity measures and objective bulbar hyperaemia grading.

Results: Many attempts to measure corneal transparency have been described in the academic literature, mainly to investigate the effects of refractive surgery. Assessment of grading scale images identified that the change between grades was best described by quadratic parametric or sigmoid three-parameter functions. Scales depicting corneal light scatter over the pupil (Annunziato and Vistakon-Synoptik) were best correlated to average intensity. However, corneal optic section images (Efron scale) were most strongly correlated to variations in intensity across the optic section. The significant increase in corneal thickness induced in the oedematous eye (14.3%, $P < 0.001$) and its subsequent recovery was most strongly correlated with the intensity variation across the corneal section, accounting for 88.7% of the variance.

Conclusions: Corneal oedema is best determined by the intensity variation across the width of a corneal section. Corneal oedema induced by soft contact lens wear is not easily determined over the pupil area by sclerotic scatter illumination techniques.

Surgical management of presbyopia

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The holy grail for refractive surgeons is the management of presbyopia. A multitude of techniques have been tried to surgically manage this problem and this talk is an overview of what is available and the results that can be achieved. Corneal treatments include presbyopic ablation profiles with the excimer laser. Scleral techniques include scleral expansion bands and 'reading implants'. With reading implants, in data submitted for the European CE mark for this product, approximately 96% of patients were able to read J2 uncorrected post-operatively without correction with a follow-up of up to 4 years. The British experience is very similar although follow-up as yet is relatively short. Intraocular tech-

niques include multifocal implants and the new accommodating lenses. The authors experience is that the newest accommodating implants give about 2–2.5 D of accommodation. All available techniques, at present, reduce the dependence on glasses for close work and do not remove the need for them completely.

Factors that influence patient choice in laser refractive surgery or contact lenses

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Purpose: To explore patient's motivations in choosing refractive surgery or contact lenses and what factors influence patient choice of practice.

Methods: A one-page questionnaire was presented to consecutively presenting patients at four refractive surgery clinics (one low prices high street laser clinic, one long established laser clinic, one large optical company with an in-house laser facility and one consultant ophthalmologist) and three contact lenses practices (one specialist CL practice, one large optical company and one low price optical company).

Results: Overall, amongst the refractive surgery patients ($n = 212$) there was a prevalence of female patients, mean age for all clinics was 39.2 ± 10.6 years. Amongst the contact lens patients ($n = 115$) there was a prevalence of female patients (similar to previous studies), mean age for all clinics was 30.8 ± 12.4 years. The main reason for choosing refractive surgery or contact lenses seemed to be cosmetic reasons, work related and sports. Reasons for not choosing contact lenses were inconvenience (79%), dry eyes (20%) and overwear (22%). Reputation of the clinic was the most common reason (58%) for selecting a refractive surgery practice. The authors also disseminate the results to look at differences amongst the four refractive surgery clinics and the three contact lens practices.

Conclusions: Primary motivations for refractive surgery seemed to be cosmetic reasons since few patients cited contact lens complications that could not be managed. Contact lens clinicians may be able to hold onto patients and not lose them to refractive surgery with better management. The opinions of clinicians involved in primary eye care seemed to be very influential in helping patients decide on their method of refractive correction, which is encouraging as past studies have not shown this. Patients should be encouraged to seek advice from ophthalmic clinicians and clinicians should remain impartial and fully informed.

Understanding the role of the aqueous phase in soft contact hydrogels

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Purpose: With the introduction of silicone hydrogels there has been increasing interest in reducing the equilibrium water content to enhance oxygen permeability through the contact lens. However, it has been proposed that the aqueous phase plays an important role in ensuring on eye movement during overnight wear. This study describes the results from a range of laboratory research methods, which can be applied to assess the necessary properties of the aqueous phase.

Methods: Rotational mobility of water and solutes is measured using electron spin resonance and proton and sodium nuclear magnetic resonance. Translational ion mobility is assessed using impedance spectroscopy, which can also be employed to monitor aqueous phase continuity by dielectric techniques.

Results: Both rotational and translational mobility within hydrogels is increasingly restricted with reduction in water content. When compared with bulk solution there is typically a $100\times$ reduction in mobility of ions and water in 38% HEMA. Ion mobility is severely restricted when further lowering the water content.

Conclusions: The results indicate that a balance between the polymer and aqueous phases is imperative to ensure oxygen and ion/water co-continuous phases. On eye movement may be influenced to a greater extent by hydraulic relaxation than ion mobility across the contact lens. By using a group of research tools as outlined, it provides results that can predict whether it is viable to advance a polymer to the next stage of development and expensive clinical trials.

The death of GP lenses is highly exaggerated

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It is the year 2004 and the GP lens is alive and well. The contact lens field has made a change that has set the stage for the 21st century. Continuous vision is a reality. Hyper Dk/t silicone hydrogels for up to 30 days, hyper Dk/t GP lenses for up to 30 days, corneal refractive therapy (CRT), intra-limbal lenses, semi-scleral lenses are now all available. The physiological breakthroughs of hyper Dk/t materials will be thoroughly discussed especially in relation to the GP situation. The scientific data and physiological benefits of hyper Dk/t will be thoroughly discussed, including the latest results on corneal ulcer incidence for CW GP lens use will be discussed. A thorough discussion of how to integrate hyper Dk/t GP lenses into your practice from daily wear to continuous wear, from spherical to custom lenses will be discussed.

The era of continuous wear, GP hyper Dk contact lenses

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The contact lens field has made a change that has set the stage for the 21st century. Continuous vision is a reality.

Hyper Dk/t silicone hydrogels for up to 30 days, hyper Dk/t GP lenses for up to 30 days, and corneal refractive therapy (CRT) are now all available. The physiological breakthroughs of hyper Dk/t materials will be thoroughly discussed. What does hyper Dk/t really mean and how is it different than lenses of the past? The scientific data and physiological benefits of hyper Dk/t will be thoroughly explained including corneal epithelial changes and, in particular, *Pseudomonas* adhesion to epithelial cells and risks of corneal ulceration. The second hour will cover the clinical differences between GP and silicone hydrogel CW with an emphasis on GP 30-day CW, including trouble shooting with both modalities.

The presentation objectives are to:

- To review the meaning of Dk and Dk/t in relation to clinical practice.
- To understand the physiological differences with hyper Dk/t contact lens materials.
- To understand the physical properties of hyper Dk/t materials.
- To review relative risks of corneal infection by lens transmissibility.
- To understand the FDA results from the CW studies and to make correlations to clinical practice.
- To introduce possible problems with hyper Dk/t materials.
- To understand how to resolve such problems.
- To compare and contrast the soft and GP CW.

(A) Dk values, transmissibility categories:
  (1) Oxygen permeability, Dk and its measurement.
  (2) Oxygen transmissibility, Dk/t.
  (3) Benjamin oxygen transmissibility classifications.
(B) Physiological benefits of hyper Dk/t:
  (1) Confocal microscope studies on corneal epithelium.
  (2) Increased *Pseudomonas aeruginosa* adherence to the epithelium with lower Dk/t lens materials.
  (3) Clinical studies concerning *P. aeruginosa* adherence to different lenses.
  (4) Discussion of risk of corneal ulcer with different lens types.
  (5) FDA post-approval of 30-day CW lenses to verify lower rates of keratitis/ulcer.
(C) Polymer chemistry and lens materials:
  (1) Hyper Dk/t GP lens materials:
    • Hardness.
    • Deposit resistance.
  (2) Silicone hydrogel materials:
    • Water content.
    • Rigidity.
(D) Results of the FDA study for Menicon Z.
(E) Trouble shooting silicone-hydrogel:
  (1) Conjunctival staining.
  (2) Mucin balls.
  (3) Epithelial splitting.
(F) Trouble shooting GP for 30-day CW:
  (1) Three to nine stainings.
(G) Ulcer incidence with both modalities:
  (1) Thirty-six cases reported world-wide so far with silicone-hydrogel.
  (2) No reported cases of ulcer with GP lenses.
  (3) Post-FDA approval studies:
    • Rationale.
    • Structure.
    • Function.
(H) Results of a clinical comparative study between Night&Day versus Menicon Z for 30-day CW (UMIST, Morgan, Maldonado, Efron).
(I) Summary/discussion.

Scleral lenses for keratoconus and transplants: analysis of visual outcome

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Purpose: This presentation reviews the current management of keratoconus or other primary corneal ectasia (PCE) and corneal transplant, with scleral contact lenses (ScCLs), the cases assessed from a dedicated ScCL Clinic at Moorfields Eye Hospital. The visual acuities for both groups are compared, and the relative visual performance of the fellow eye noted.

Methods: The principal underlying contact lens indication, and the visual acuities for a group of patients with PCE or corneal transplant was recorded between September 1999 and January 2004.

Results: Eight hundred and five patients (1308 eyes; 1070 PCE, 238 transplants), a mix of new referrals and existing ScCL wearers, were seen in the 52-month period. At the time of writing, 429 (686 eyes) continued with lens wear, PCE 559 eyes, transplant 127 eyes, the remainder either discontinued wear, did not proceed at the time of the trial, were in progress pending a first after-care appointment or lost to follow-up. In the PCE group, 83 eyes achieved 6/6 or better, 305 eyes achieved 6/9 to 6/12, 114 eyes achieved 6/18 to 6/24 and 41 eyes achieved below 6/24. The transplants achieving the same acuities were 58, 76 and 7, with 3 at less than 6/24. The ScCL wearing eye in unilateral PCE cases was better in 9 cases, and worse than the fellow eye in 47. The respective figures for unilateral transplants was the reverse pattern, with 34 and 9 cases, respectively.

Conclusion: ScCLs provide a feasible alternative to corneal lenses in the management of PCE and corneal transplant. The expected visual acuity for transplants fitted with ScCLs is approximately two Snellen lines better than for PCE. In unilateral transplant cases, the ScCL wearing eye generally had a better acuity than the fellow eye, but for PCE requiring just one ScCL, the fellow eye more often was the stronger seeing eye.

Orthoptic indications for contact lens wear

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Orthoptic anomalies are prevalent: they are encountered in at least 5% of patients seen in a typical primary eye care practice. Many orthoptic anomalies are best treated with contact lenses, and recent developments in contact lens practice make this approach increasingly feasible. Several cases are reviewed that highlight the role of contact lenses in treating orthoptic anomalies. Amblyopia affects about 3% of the population, and anisometropic amblyopia may be the most common form of amblyopia [Attebo et al., 1998]. Winn et al. (1988) showed that contact lens correction of anisometropia maintains the aniseikonia at a minimum level in axial as well as refractive anisometropia. So, from an optical point of view contact lenses are the preferred method of correcting anisometropia, and it is often argued that anisometropia should be corrected as young as possible to most effectively treat amblyopia. However, fitting contact lenses to patients, particularly children, with anisometropic amblyopia has been problematic because there is no immediate binocular acuity improvement when the contact lenses are inserted which reduces patient motivation. Extended wear with silicone hydrogels represents a breakthrough for these cases. A series of anisometropic patients, mostly children, who have been corrected in this way are presented. In addition to improvements in the best corrected acuity of the amblyopic eye, some cases show good stereoacuity with contact lenses in patients who could not obtain this with spectacles. Other cases are described where contact lenses were used to correct accommodative esotropia and, in an unusual case, an actor with high myopia, astigmatism, and decompensating esophoria was corrected with soft toric contact lenses incorporating two prism diopters base out each eye. It is concluded that there are orthoptic anomalies where contact lenses are the preferred mode of correction. It is in patients' best interest for practitioners to recommend contact lenses in these cases.

Utilisation of spin probes to investigate the aqueous phase in soft contact lens hydrogels

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Utilisation of spin probes to investigate the aqueous phase in soft contact lens hydrogels.

Purpose: This study aims to investigate the aqueous phase by electron spin resonance and ^{23}Na nuclear magnetic resonance. By monitoring the rotational mobility of a spin probe and sodium ions in different hydrogels, it is proposed that this will provide a useful insight into the internal dimensions and micro viscosities of the aqueous phase in hydrogels.

Method: For the ESR technique, samples were hydrated with an aqueous solution of the NaTMIOS spin probe. Line widths were obtained from the spectra with the fitting programs EWVOIGT and LOWFIT.BAT. ^{23}Na NMR studies were undertaken on a temperature controlled Bruker MSL 300 spectrometer operating at 79.387 MHz for sodium. By applying the CPMG pulse sequence spin–spin relaxation T2 values were obtained for both silicone and conventional hydrogels.

Results: Curve fitting analysis of the two techniques provides evidence for a range of mobility within each of the hydrogels under investigation. ESR results display spin correlation times from 10^{-6} to 5×10^{-11} s for 38% EWC HEMA and 0.154 mol saline, respectively, whereas ^{23}Na T2 relaxation is reduced by a factor of 60. Inter-relating these two techniques shows that the environment to a similar extent affects both probes since both have volumes in solution of the same order of magnitude.

Conclusions: The mobility of the ESR probe and sodium ion reduces as a function of water content. Results indicate both techniques provide evidence for up to three different sites of mobility, which may either indicate different states of water or different volume fractions of the aqueous phase within hydrogels.

Transverse ion mobility in hydrogels by impedance spectroscopy

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Purpose: The extensive patent literature outlines the necessary properties of silicone hydrogels to maintain on-eye movement. It has been proposed that the water content is critical to ensure sufficient ionic and hydraulic permeability. This study outlines a method to measure ion mobility and aqueous pathway continuity and compare the results with those stated in previous reports.

Methods: Data was obtained using a Solartron 1260 impedance analyser supported by Z Plot software. Sample hydration was maintained by constructing a custom designed cell permitting controlled sample/electrode contact pressure. By varying the molar concentration of the aqueous phase within the hydrogel, it is possible to measure both ion mobility and dielectric properties.

Results: In high water content hydrogels, ion and oxygen mobility are equally obstructed by the polymer network, however, in hydrogels with water contents lower than 38% EWC, there is a very sharp drop in ion mobility. Conductivity of amidose saline was 2 Sm^{-1}, 38% HEMA and PureVision 0.02 Sm^{-1}, and Night&Day 1.42×10^{-5} Sm^{-1}. An important outcome of this study is that CIBA Vision Night&Day had a ion mobility in the same order of magnitude as a conventional HEMA/MMA hydrogel with EWC of 26%.

Conclusion: The low ion mobility exhibited by the CIBA Vision Night&Day material suggests that ion transport through the material plays a less significant role to ensure on-eye movement. Careful dielectric analysis can determine

if the aqueous phase is a series of continuous or blocked pathways within the hydrogel.

Concentration of water soluble gentamicin in aqueous, delivered by corneal collagen shields

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Purpose: This was a pilot prospective non-randomised control, single centre trial to evaluate the efficacy and safety of corneal collagen shield as a mode of antibiotic delivery after cataract operation. The objective of this study was to see whether minimal inhibitory concentration (MIC) of gentamicin is achieved in the aqueous humour when soaked in collagen corneal shield.

Methods: Ten subjects were recruited from patients who are due to have routine cataract surgery from day surgery unit at Coventry and Warwick Hospital. In addition to the normal pre-operative regime of dilating the pupil with topical drops, a self-dissolving collagen shield soaked in gentamicin (40 mg/ml for 30 min) was placed on the eye. Exposure time will for variable intervals before surgery (minimum time: 30 min; maximum time: 180 min) to allow different lengths of time for the antibiotic to soak through the cornea into the anterior chamber and so determine the length of time required to reach a therapeutic dose of the antibiotic where it is needed. The contact lens was taken off the eye in the operating theatre, just before starting the actual procedure. A tiny sample of fluid (0.2 ml of aqueous) was taken from the eye through the normal cataract wound at the start of the operation and sent to the laboratory to be analysed for the amount of antibiotic. The exclusion criteria included previous eye surgery, only good eye, ocular surface problems, associated ocular co morbidity (glaucoma, retinal disease, uveitis etc).

Results: The collagen shield which was very comfortable mode of delivery from patients of view. The concentration of antibiotics at various times will be discussed and the results were encouraging which has prompted a further prospective study.

Effects of long-term lens wear on the corneal epithelium

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Purpose: Corneal epithelial thinning follows short-term wear of silicone hydrogel contact lenses (CLs). After 12 months of wear, there is partial recovery of epithelial thinning, however, the long-term effects of wear are unknown. The aim of this study was to measure the effects of long-term wear of these CLs on the epithelial thickness profile and basal epithelial cell appearance in a prospective, single centre, masked, cross-sectional study.

Methods: Fourteen silicone hydrogel CLs wearers using lenses on an extended wear basis (mean experience 5 ± 1 years), 23 wearers using hydrogel CLs on an long-term extended wear basis (mean experience 13 ± 4 years) and 18 non-lens-wearing age-matched controls were recruited. Epithelial thickness at the central cornea and at four peripheral locations was measured using a modified optical pachymeter. Cell regularity and intensity of light backscattered from the basal epithelium were assessed using a slit scanning confocal microscope.

Results: There were significant differences in epithelial thickness between all subject groups (ANOVA, $P < 0.001$; post-hoc testing $P < 0.005$). Hydrogel wearers had the thinnest central corneal epithelium (46 ± 10 mm), followed by silicone hydrogel wearers (54 ± 14 mm) and non-wearing controls (58 ± 9 mm). Topographical position did not affect epithelial thickness. Epithelial thinning was not associated with the duration of wear. Hydrogel CL wear was associated with reduced basal epithelial cell regularity, however, no reduction was demonstrated in silicone hydrogel CL use. The transparency of the basal cell layer was unaffected by CL wear.

Conclusions: Long-term wear of silicone hydrogel CLs is associated with epithelial thinning but to a lesser degree than observed with hydrogel CLs. Morphological alterations to the basal epithelial cell layer are observable in long-term hydrogel wearers. A cumulative effect of the duration of wear on the changes observed could not be demonstrated, which may offer some reassurance for wearers with prolonged exposure to CL wear.

Preliminary results of the comparison of multiple survey instruments for patient satisfaction with overnight orthokeratology study

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Purpose: To compare symptoms and satisfaction before and after corneal refractive therapy (CRT). Secondarily, to assess change in corneal thickness with CRT.

Methods: Forty CRT patients were enrolled at the New England College of Optometry. Visual acuity, refraction, corneal topography, symptoms and satisfaction (NEI RQL-42), central corneal thickness and corneal epithelial thickness were measured at baseline, 1 day, 1 week, 1, 3, 6 months and 1 year. Three-month data are reported.

Results: Of the 40 CRT patients, 9 discontinued prior to completion of the study. Mean subscale scores for the NEI RQL-42 at the 32-month visit were: clarity of vision = 69.3; expectations = 51.1; near vision = 90.0; far vision = 88.2; diurnal fluctuations = 74.0; activity limitations = 96.5; glare = 62.4; symptoms = 82.4; depen-

dence on correction = 84.5; satisfaction with correction = 75.5. Higher scores indicate better quality of life. There were no statistically significant differences in symptoms when compared to a sample of LASIK patients at the Ohio State University at the 1- or 3-month visits after adjusting the comparisons for baseline differences between groups. Full corneal thickness measurement showed that changes in the central cornea were statistically significant at 1 week ($P = 0.008$). There was a general trend towards central thinning and peripheral thickening. Data collected for epithelial thickness did not show significant changes.

Conclusions: The lack of differences in symptoms and satisfaction between CRT and LASIK patients following treatment are attributed either to a lack of sensitivity of the instrument (NEI RQL-42) to detect differences, or that no difference between these two groups exists in terms of quality of life. Changes in total corneal thickness were consistent with previously reported studies; however, the epithelial thickness changes are not, perhaps due to limitations of the instrumentation.

Corneal response of chemical agents released by hydrogel and silicone-hydrogel lenses as a function of time

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Purpose: The adsorption and release of chemical agents found in commercially available multi-purpose solutions (MPS) were evaluated to determine the effect on corneal staining and subjective symptoms.

Methods: A series of pilot research studies were conducted as a 2-week, prospective clinical trial, using a double-masked, randomised, crossover design. Adapted asymptomatic lens wearers wore hydrogel or silicone-hydrogel contact lenses for a maximum period of time each day. New lenses were dispensed for each wear period. Prior to wear, lenses were pre-soaked in Alcon-OPTI-FREE-Express-MPDS, B&L-ReNu MultiPlus-MPS, CIBA Vision-SOLO-care-PLUS MPS, or AMO-Complete-MoisturePLUS-MPS for 12 h overnight. Subjects rated comfort and ocular symptoms. The ocular surface was examined at baseline and after lens removal with fluorescein. The cornea was evaluated according to its type (grades 0–4) and area (0–100%). The uptake of chemical agents from new, unworn control lenses was determined in vitro by UV spectroscopy.

Results: Clinically significant levels of relatively asymptomatic corneal staining were observed at 1 and/or 2 h when subjects wore the group I and II lenses soaked in the PHMB-based systems. The PHMB systems showed greater incidents of staining than the POLYQUAD group. All signs were reduced or not measurable after 6–8 h. When subjects used the POLYQUAD-based solution with lens groups I, II and IV, only minimal staining was observed at 1 and 2 h of wear. Preliminary results from the in vitro experiments demonstrated that continued cycling was associated with uptake of PHMB, Aldox, Tetronic 1304 and 1107 into the lenses.

Conclusions: Preliminary data indicate that subjects who wear group II hydrogel or group I silicone-hydrogel lenses soaked in a PHMB-based system on a daily wear basis, may exhibit clinically meaningful corneal staining during the first few hours after insertion without the associated subjective symptoms.

Dynamic wetting behaviour of pHEMA–MAA and silicone hydrogel contact lenses

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Purpose: Utilise a new technique to measure dynamic contact angle as an indicator of contact lens wettability for hydrogel lenses.

Methods: A sessile water drop technique was used in conjunction with high speed video equipment to measure advancing dynamic contact angles for unworn and patient worn contact lenses. The curved profile of the lens surface was analysed using a fitting algorithm to calculate the contact angles. The lenses were cycled through buffered saline and air exposures to simulate exaggerated blinking conditions. Measurements were made in the presence of various non-ionic surfactants and disinfection products.

Results: The contact angles of the pHEMA–MAA lenses increased from approximately 20–100° after 9–10 cycles and they were independent of the lens water content. The change from the hydrophilic to hydrophobic lens surface could not be reversed when the dewetted lens was repeatedly soaked in buffered saline solution. For silicone hydrogel lens, the initial contact angles were higher than those observed for the pHEMA–MAA lens. Dewetting kinetics were much slower in the case of the silicone hydrogel lens. The influence of surfactant pre-treatment on the wettability of the pHEMA–MAA lens showed Tetronic-1304 gave excellent wettability. Comparatively, the lens pre-soaked in Tetronic-1107 solution showed rapid dewetting following the early cycling stages, indicating low retention of the Tetronic-1107. These same trends were observed for commercial disinfection products containing these surfactants.

Conclusions: The pHEMA–MAA lenses showed significant dewetting properties when the lenses were cycled through saline solution–air. The dewetting effects of the silicone hydrogel lenses were significantly different compared to the pHEMA–MAA lens. There was a strong lens wetting dependency on the type of surfactant used in the pre-soaking solution and subsequent substantivity of the surfactant. The different surface chemistries of the pHEMA–MAA and

silicone hydrogel lenses appeared to play a key role in the observed lens dewetting phenomena.

Wearer demographics in the US post-approval evaluation of lotrafilcon A

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Purpose: To profile the patient demographics among patients prescribed 30 night continuous wear in the post-market surveillance study for lotrafilcon A lenses in the US.

Methods: Baseline demographics were self-reported by the 6245 enrolled wearers. The distribution of gender and refractive status was compared to concurrent contact lens wearer databases. The distribution of age and years of lens wear was described.

Results: Males comprised 36% of the wearers in the post-approval evaluation compared to 32% of the referent database ($P < 0.01$, Chi-square test). The median lens power was −3.00 D, yet there were twice as many patients with refractive error above −6.00 D (1145 wearers or 18.3%) in the lotrafilcon group compared with data from other types of lenses (9.1%, $P < 0.05$, Chi-square test). Of the enrolled cohort; 14.8% or 924 wearers were aged 50 years or older and 33.8 were age 40 years or older. Eight hundred (12.8%) of the wearers in this cohort reported more than 20 years of lens wearing experience.

Conclusions: Continuous wear lotrafilcon A lenses have been prescribed to many types of patients, including a substantial proportion of middle-aged patients, a large proportion of patients with high refractive errors and long years of wearing experience. The advantage of high oxygen transmissibility will be beneficial to a wide variety of contact lens wearer.

Review of indications of scleral contact lenses in tertiary hospital

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Purpose: For decades, scleral contact lenses have been fitted in the hospital eye services for therapeutic purposes. The application of scleral lens use, is widely known. The purpose of this study was to analyse the indications of using scleral contact lenses in a tertiary referral centre.

Methods: A retrospective analysis of the scleral contact lens database at the Optometry Department of the Birmingham & Midland Eye Centre over the past 2 years was done. The scleral contact lenses were divided into three subgroups: (1) polymethyl methacrylate (PMMA)-sighted lenses for visual purposes; (2) PMMA-cosmetic scleral contact; and (3) rigid gas permeable (RGP) scleral contact lens for visual purposes (innovative sclerals).

Results: In total, 193 scleral contact lenses were used: (a) 60% (115) were used in moderate/advanced keratoconics, post-keratoplasty astigmatism to improve visual acuity; (b) 23.32% were used as cosmetic scleral lenses for traumatic purposes, pthisical eyes and for decompensated cornea; and (c) 17% (33) eyes had innovative sclerals mainly in keratonics intolerant to other varieties of contact lenses.

Conclusions: Scleral contact lenses continue to have a very wide application. In the vast majority of cases reviewed in this busy tertiary centre, scleral lenses formed an essential form of visual and non-visual correction.

Clinical performance and corneal staining associated with silicone-hydrogel materials used on a daily-wear basis

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Purpose: The purpose of this study was to determine the clinical performance of one polyhexanide (PHMB)-based system (ReNu MultiPLUS) and one peroxide (PX)-based system (AOSept), when used to disinfect PureVision (PV) and Focus Night&Day (FND) silicone hydrogel (SH) lenses, worn on a daily wear (DW) basis.

Methods: A 2-month prospective clinical trial was conducted on 20 myopic soft lens-wearing subjects who were symptomatic of dryness with their contact lenses. Subjects were refitted with a contralateral pair of PV and FND lenses, which were worn on a DW basis. Subjects were randomly assigned ReNu or AOSept for two consecutive 1-month periods, using a cross-over design. After each month, a new pair of lenses was dispensed. Subjects were examined at dispensing and after 7 and 28 days.

Results: Subjectively, the lenses and care regimens behaved similarly, with no significant differences in levels of comfort, dryness, vision or stinging on insertion for any of the combinations (P = NS). Lens comfort reduced ($P < 0.001$) and dryness increased ($P < 0.001$) over the day of wear, regardless of the lens/care regimen combination (P = NS). PX-disinfected lenses showed no statistically significant differences in corneal staining from baseline with either lens type (P = NS). ReNu produced significantly greater corneal staining at both follow-up visits than at baseline ($P < 0.001$), with more staining observed with the PV lenses than the FND lenses ($P < 0.001$). Unacceptable staining occurred in 47% of the ReNu-PV eyes and 21% of the ReNu-FND eyes. The severity of the staining was generally mild (<25 on a 0–100 scale) and demonstrated a pattern in which peripheral staining was greater than that observed centrally.

Conclusions: These results indicate that certain care regimens used with SH materials have a potential to produce

different patterns of corneal staining than that observed with HEMA-based materials and that the staining obtained is relatively asymptomatic. Lens care regimens must be carefully evaluated for their clinical performance with SH materials and practitioners must be aware that not all care systems behave alike with such materials.

Do progressive contact lenses negate ocular accommodation in pre-presbyopes—implications for myopia control?

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Purpose: Several recent studies have suggested that it may be possible to retard the progression of myopia in children with progressive spectacles. The rationale for their use is that positive power at near reduces accommodative effort (perhaps increasing accommodative accuracy) and consequently reduces the stimulus for growth of the posterior vitreous segment. A logical next step would be to consider progressive contact lenses. Theoretically, these should cause the young patient to accommodate less at near than with single vision contact lenses and this is examined in this study.

Methods: Twenty subjects (12 female, 8 male, average age 21.40 ± 3.07 years) with a range of mean spherical refractive error (-5.50 to $+3.50$ D) viewed in random order, high contrast static targets (Maltese cross) at 0.1, 0.5, 1.0, 2.0 and 3.0 D accommodative demand matched for angular subtense in free space. The measurements were made with subjects fully corrected (in random order) by each of Acuvue daily disposable (SVCL), Ultravision Igel multifocal (PACL) and Acuvue bifocal (BICL) contact lenses. Accommodation was monitored objectively with the open view IR Shin Nippon SRW-5000. Both PACL and BICL had a near addition of $+2.50$ D. Three indexes of accommodative accuracy were used: response level for a 3 D stimulus, accommodative slopes and error indexes derived from accommodative stimulus–response plots.

Results: When corrected by SVCL, the accommodative response at 3.0 D demand was 2.21 ± 0.52 D and the slope and error index of the stimulus response curve 0.95 ± 0.16 and 0.79 ± 0.46, respectively. However, with progressive contact lenses, the response were significantly lower (BICL: response 1.73 ± 0.56 D ($P = 0.0003$), slope 0.82 ± 0.18 ($P = 0.009$); PACL: response 1.83 ± 0.58 D ($P = 0.02$), slope 0.82 ± 0.11 ($P = 0.001$)).

Conclusions: The results suggest that patients accommodate less with PACL and BICL than with SVCL. If reducing accommodative effort is able to retard the development of myopia, contact lenses may be more successful than spectacles as the near addition remains in the line of sight with eye movement and they are less likely to be removed by children. However, significant accommodation is still exerted by pre-presbyopes wearing progressive contact lenses, despite the lack of theoretical need.

Impact of previous extended and daily wear schedules on signs and symptoms with high Dk lotrafilcon a lenses

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Purpose: The purpose of this study was to determine the impact of previous lens wearing schedule on the signs and symptoms with lotrafilcon A lenses.

Methods: In a multi-centre clinical trial 140 subjects with previous daily wear (DW) and 140 with previous extended wear (EW) were enrolled and re-fit with lotrafilcon A (Night&Day) lenses to use on an up to 30 night continuous wear basis. Their ocular signs and symptoms were tracked for 1 year.

Results: Nearly 85% of the subjects completed the year. Signs of limbal and conjunctival redness and neovascularisation were significantly improved by the 1-week visit. Papillary changes improved in the former EW group only. No significant change was noted in conjunctival or corneal fluorescein staining. A significantly larger proportion of the DW subjects presented at baseline with frequent or moderate to severe symptoms compared to previous EW subjects. Severity and frequency of dryness during the day and the severity of end of day dryness were reduced significantly by the 1-week visit in the former DW subjects. Frequency of the end of day dryness was significantly decreased by the 1-week visit and continued to resolve over the first 6 months of the study. The severity of end of day dryness diminished sharply during the first week of lotrafilcon usage.

Conclusions: Previous DW and EW showed slightly different time course in the resolution of the physiological changes that had developed from their previous lens wear. Previous DW subjects presented at baseline with greater symptoms compared with users of EW. Most subjects experienced relief of their symptoms within the first week of lotrafilcon A wear.

Clinical and biochemical changes with silicone-hydrogel contact lenses

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Purpose: Despite a careful and regular cleaning regime, surface deposits adsorbed on silicone-hydrogel (SiH) contact lenses may induce inmmunological and/or pathological reactions leading to adverse events such as contact lens papillary conjunctivitis and contact lens peripheral ulcers. This

study reports the clinical and biochemical ocular changes experienced by neophyte SiH wearers monitored over an 18-month period.

Methods: Forty-seven subjects were fitted with SiH lenses and randomly allocated one of the two materials currently on the market (balafilcon A or lotrafilcon A) on either daily or continuous wear basis. New techniques for objective grading (i.e. red extraction) of bulbar and palpebral hyperaemia were employed together with tear meniscus height and subjective measurement of non-invasive tear break-up time before and 1, 3, 6, 12 and 18 months after initial fitting. The amount of protein extracted from worn lenses was measured using a combination of immunoassays and electrophoretic techniques.

Results: After 18 months of SiH contact lens wear, a significant increase in bulbar and palpebral hyperaemia was observed in all contact lens groups ($P < 0.05$). SiH lenses did not induce significant changes in tear meniscus height and non-invasive break-up time ($P > 0.05$). A significant increase in the positive incidence of specific protein markers was found with contact lens wear.

Conclusions: Significant changes in clinical signs were observed in neophyte SiH wearers and were associated with the positive incidence of specific protein markers. None of the proteins investigated could be regarded as being specific to one particular disease or adverse response, although the findings presented would suggest that their assessment may prove useful in the quantification of distinct events in contact lens wear. The detection of protein markers in the ocular environment together with clinical monitoring of ocular physiology provides extremely valuable information for the development of contact lens materials and solutions as well as for the therapeutic use of drugs and the management of a variety of contact lens disorders.

Case report: silicone hydrogel microbial keratitis

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The case report relates to a contact lens wearing patient referred with painful, photophobic red eye to Croydon Eye Hospital casualty by a local optometrist. The report describes a case of *Pseudomonas aeruginosa* ulcer with 30-day continuous wear silicone hydrogel, highlighting contributory factors to the severity of the event that lead to vision loss and permanent scarring. The patient, a 26-year-old female, had successfully worn Easy Vision All Day All Night contact lenses for 3 years, changing her contact lenses monthly, and wearing them without removal on average of 30 days. She presented to her contact lens practitioner at midday complaining of pain, itchiness, redness, light sensitivity. After examination, she was instructed not to wear contact lenses and was sent home. The following day the patient consulted an optometrist local to her home with increased lacrimation, redness and pain and was immediately referred. She was diagnosed to have microbial keratitis and corneal scrapping isolated *Pseudomonas aeruginosa*. Aggressive treatment was immediate (ofloxacin hourly, gentamicin hourly) and included hospitalisation. Examination 1-month post-event included logMAR visual acuity, videokeratoscopy, videoaberroscopy, slit lamp photography, confocal microscopy. It revealed permanent VA loss, increased corneal aberrations, multiple deep corneal scarring within the pupillary area and endothelial cell loss. The poster will describe in details this case history that confirms that despite full respect of the cornea oxygen physiological needs, silicone hydrogel can produce mechanical corneal damage that facilitates bacterial penetration and infection. The case highlights the need for rapid and correct diagnosis and the very grave consequences of delay in treatment.

Detection of keratoconus by videokeratoscopy (BCLA Dallos Award)

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Purpose: Clinicians habitually describe the distortions associated with keratoconus as irregular astigmatism. In fact, the distortions are the manifestations of increased level, compared to normal, of higher-order aberrations. Several workers have suggested the use of videokeratoscopes to detect early keratoconus, and have developed proprietary algorithms. Videokeratoscopes becoming widely used in a clinical routine, it becomes important to quantify the optical quality of the cornea with an established analytic technique. In the field of ocular aberrations measurements, there is now a consensus to use Zernike polynomials to describe aberrations. The aim of the current study was to develop a Zernike based keratoconus detection scheme that is usable for all instruments.

Methods: The study was carried out on 45 diagnosed keratoconus eyes and 28 suspected keratoconus eyes. The data obtained was compared to a reference population of 870 normal eyes.

Results: Total fourth-order aberrations and coma along *y*-axis (Z3-1) were the best detectors for the differentiation between suspected keratoconus and normal corneas (specificity 81.6%, sensitivity 75.0% for fourth-order aberrations; specificity 71.9%, sensitivity 89.3% for Z3-1). The total fourth-order aberrations and coma along *y*-axis (Z3-1) were also the most efficient detectors for diagnosed keratoconus (specificity 93.3%, sensitivity 94.2% for fourth-order aberrations; specificity 88.9%, sensitivity 94.1% for Z3-1).

Conclusions: The results demonstrated an improved use of videokeratoscope as a diagnostic tool for keratoconus detection that can be used for all types of videokeratoscopes.

The relationship between corneal thickness, corneal topography and ocular surface temperature, as measured by infrared thermography

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Purpose: The origin of the source of the thermal radiation from the anterior eye is ambiguous. This study examines the influence of corneal thickness, corneal topography and tear film stability on ocular surface temperature, by use of non-contact infrared thermography.

Methods: Seventeen subjects (nine males, eight females; age 27.1 ± 3.8 years) underwent measurement of central corneal thickness (ultrasound pachymetry, Nidek UP-1000), anterior surface corneal topography, corneal thickness and anterior chamber depth (Orbscan), non-invasive tear break-up time (TBUT, Tearscope) and non-contact ocular surface temperature (OST, ThermoTracer TH7102MX). The dynamic ocular surface temperature profile was measured for 8 s continuously after a blink. Custom-designed software allowed quantitative objective analysis of the digitised thermal images over the surface of the anterior eye, which could be mapped on to the corresponding corneal thickness and topography maps.

Results: Central OST is strongly correlated with OST of the more peripheral conjunctiva ($r = 0.94$; $P < 0.001$). OST was unrelated to corneal thickness (ultrasound: $r = -0.31$, $P = 0.23$; Orbscan: $r = -0.26$, $P = 0.33$) across all regions of the cornea. OST was also unrelated to corneal topography ($r = -0.38$, $P = 0.13$) and anterior chamber depth ($r = -0.06$, $P = 0.82$). The relationship between OST and tear film quality approached significance ($r = -0.45$, $P = 0.07$).

Conclusions: The physical properties of the cornea appear to have little influence on OST. These results support previous theories that OST measured by infrared thermography is principally determined by the tear film. Hence, thermography is a useful, dynamic, non-invasive method for assessing the tear film.

Effect of organically soiled contact lenses on disinfection susceptibility of *Pseudomonas aeruginosa* strains

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Purpose: We have shown that *P. aeruginosa* isolates vary in their resistance to chemical contact lens disinfectants when basic inorganic ions are made available to the bacteria during testing. Resistance appears to be linked to acute cytotoxicity. The aim of this study was to investigate the effect of organically soiled contact lenses on disinfection susceptibility of cytotoxic and invasive *P. aeruginosa* strains.

Methods: Disinfection susceptibility of five *P. aeruginosa* isolates (three invasive, two cytotoxic) was investigated using laboratory-soiled contact lenses, unsoiled (new) lenses and disinfectant only controls. The FDA/ISO organic soil model was utilised. Four disinfectants were assessed: (A) preserved with polyquaternium-1 0.001% and myristamidopropyl dimethylamine 0.0005%; and (B–D) preserved with polyhexamethylene biguanide (PHMB) 0.0001%. An initial inoculum of 5×10^5 CFU/ml was achieved, and the number of bacterial survivors was determined at 4 and 6 h post-inoculation.

Results: Susceptibility to solution A did not vary significantly between the *P. aeruginosa* strains with soiled or unsoiled lenses. However, resistance to solutions B–D varied between strains, with poorer efficacy observed with soiled compared to unsoiled lenses for at least one of the isolates ($P < 0.05$). Solution A was the only disinfectant to achieve log reductions of at least 3.0 for all strains under all test conditions. Invasive strains were more resistant than cytotoxic strains to solutions B and D at 4 h post-inoculation ($P < 0.05$).

Conclusions: *P. aeruginosa* isolates varied in susceptibility to PHMB preserved solutions in the presence of soiled lenses, but did not vary in susceptibility to solution A. Invasive strains were more resistant than cytotoxic strains to two of the PHMB preserved solutions when associated with soiled lenses. Investigation of a wider range of invasive and cytotoxic isolates, and alternative soil models, will further enhance our understanding of *P. aeruginosa* resistance to contact lens disinfection.

Evaluation of povidone-iodine as a disinfectant solution for contact lenses: antimicrobial activity and cytotoxity for corneal epithelial cells

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Purpose: Povidone-iodine (PVP-I) possesses broad-spectrum antimicrobial activity and is used clinically as a disinfectant. To evaluate the disinfectant properties and safety of PVP-I for use as a contact lens solution, we compared the effects of PVP-I with those of three chemical components of commercially available disinfectant solutions for contact lenses on microbial growth and the viability of cultured corneal epithelial cells.

Methods: The disinfectant effects of PVP-I, hydrogen peroxide (H_2O_2), polyhexamethylene biguanide (PHMB), and benzalkonium (BAK) were assessed by incubation with *Staphylococcus aureus* or *Candida albicans* and enumeration of viable cells remaining after various times (30 s to 24 h) by the ISO 14729 standard method; the concentrations of the various agents required to reduce the number of mi-

crobial cells by 3 log units during a 30 min exposure were determined. The cytotoxicity of the four disinfectant components for SV40-transformed human corneal epithelial cells was evaluated by staining with neutral red and determination of the NR50 value for a 30 min exposure.

Results: The 3 log values (in ppm) measured with *S. aureus* or *C. albicans* were 14.38 and 33.72, respectively, for PVP-I, 16499.85 and 27387.86 for H_2O_2, 93.57 and 152.95 for PHMB, and 14.96 and 9.74 for BAK. The NR50 values (in ppm) measured with corneal epithelial cells were 160.11 for PVP-I, 165.05 for H_2O_2, 50.26 for PHMB, and 12.06 for BAK. The safety margins for *S. aureus* or *C. albicans* were 11.13 and 4.75, respectively, for PVP-I, 0.01 and 0.01 for H_2O_2, 0.54 and 0.33 for PHMB, and 0.81 and 1.24 for BAK.

Conclusions: The results suggest that PVP-I has a greater antimicrobial effect and a lower cytotoxicity for human corneal epithelial cells when compared with commercially available disinfecting agents for contact lenses. PVP-I thus appears to be efficient and safe for use as a contact lens disinfectant.

Requirements for anterior eye image capture

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Purpose: To review current technologies for anterior eye image capture and describe a study to determine the minimum image pixel resolution and maximum compression appropriate for anterior eye image capture storage.

Methods: Images of the bulbar conjunctiva, palpebral conjunctiva and corneal staining (fluorecein viewed with cobalt blue illumination through a Wratten filter) were taken at the maximum resolution of the Canon CoolPix990 (2048 × 1360 pixels), MP (1280 × 811 pixels), JVC KYF58 3-chip (767 × 569 pixels) and JAI CV-S3200 single chip (767 × 569 pixels) digital cameras. The images were stored in TIFF format and further copies created with reduced resolution (using bicubic resampling) or using compression (JPEG or BMP). The images were then ranked for clarity on a 15 in. cathode ray-tube monitor (resolution 1280 × 1024 pixels) by 10 practitioners and analysed by objective image analysis grading [Contact Lens Anterior Eye 2003:26;27].

Results: Image quality was first perceived as reduced when the pixel resolution was lower than 767 × 569 pixels, regardless of the camera used. This was also the case when image were saved with greater than 50% JPEG or BMP compression. Image analysis techniques were more critical, particularly with edge detection, with features of interest best determined using medium levels of compression.

Conclusions: It is appropriate to store anterior eye images at a 767 × 569 pixel resolution and 50% JPEG compression, resulting in storage space savings of approximately 7× and 70× (compared to a 2048 × 1360 pixel resolution TIFF), respectively.

'Correction' of presbyopia with 1CU intra-ocular lenses

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Purpose: To determine the restoration of subjective and objective accommodation in eyes implanted with the 1CU accommodative intra-ocular lenses (IOL).

Methods: Twelve subjects, 20 eyes (33–78 years, average 60.7 ± 15.4 years, three males, nine females), with a 1CU accommodative intra-ocular lens implanted in one or both eyes had a full binocular refraction and both distance and near acuity measured with a logMAR chart. Subjective amplitude of accommodation was measured with the RAF rule. The objective accommodative stimulus–response curve for static (Maltese cross) targets (matched for angular subtense) was measured using the Shin Nippon SRW-5000. The subjects viewed the targets monocularly, in random order, at 0.17, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00 and 4.00 D accommodative demand. Continuous objective recording of dynamic accommodation was measured with the SRW-5000 with the subject viewing a target moving from 0 to 2.50 D at 0.3 Hz through a Badal lens system. Wavefront aberrometry measures were made through undilated pupils using the Zywave.

Results: The best corrected acuity was −0.01 ± 0.16 logMAR at distance and 0.60 ± 0.09 logMAR at near. Subjective amplitude of accommodation was 2.24 ± 0.42 D. The objectively measured static amplitude of accommodation was 0.72 ± 0.38 D, although individual responses varied greatly. The average dynamic amplitude of accommodation was 0.71 ± 0.47 D with a lag behind the target of 0.50 ± 0.48 s. Aberrometry showed a decrease in power of the lens-eye combination from the centre to the periphery in all subjects, on average −0.38 ± 0.28 D/mm.

Conclusions: The objective accommodating effects of the 1CU lens appear to be limited, although patients are able to track a moving target. The greater subjective amplitude of accommodation is likely to result from the eyes depth of focus of and the aspheric nature of the IOL.

Clinical and subjective response to daily wear of a high Dk silicone hydrogel among adapted low Dk soft contact lens wearers

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Purpose: To examine the clinical and subjective response of adapted, low oxygen permeable (Dk) daily wear (DW) soft contact lens wearers when dispensed for 1 month in a low

water, high Dk lotrafilcon A silicone hydrogel soft contact lens for DW.

Methods: Eighty-seven subjects who had at least 6-month experience wearing low Dk soft contact lenses for at least 5 days per week for at least 8 h per day for DW were dispensed to wear lotrafilcon A lenses for DW for 1 month. Subjects used their habitual lens care systems with the lotrafilcon A lenses. Follow-up visits were at 1 week and 1 month. Eight-one subjects completed the trial.

Results: Biomicroscopy signs of conjunctival redness, conjunctival staining, corneal neovascularisation, limbal redness and papillary conjunctivitis showed improvements after 1-week and 1-month wearing lotrafilcon A lenses. Signs of corneal oedema, corneal infiltrates, epithelial microcysts and mucin balls were clear at dispensing and remained clear at each follow-up. Corneal staining averaged 0.1 (1–4 scale) at dispensing and all follow-up visits. Biomicroscopy signs improved for 57% of eyes at 1 week and for 74% of eyes at 1 month. On average, 69% of subjects reported symptoms of redness, dryness or irritation at baseline. At 1 week 52% and at 1 month 53% of subjects noted these symptoms. Forty-nine percent of subjects reported an improvement in the time they could comfortably wear the lotrafilcon A lenses.

Conclusions: The results from this trial indicate that clinical improvements are seen and subjective benefits are experienced by adapted low Dk DW soft contact lens wearers who wear high Dk silicone hydrogel soft contact lenses.

Changes in hyperaemia subsequent to refitting long-term low Dk lens wearers with silicone hydrogel lenses on a daily wear basis

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Purpose: High Dk silicone hydrogel (SH) lenses are able to offer many physiological advantages for daily wear in addition to the continuous wear modality for which they were originally developed. The purpose of this study was to investigate the effect of refitting long-term low Dk lens wearers with SH lenses for daily wear on ocular hyperaemia.

Methods: As part of a larger cohort, successful low Dk lens wearers were recruited to participate in this study. To date, 35 subjects (7.6 ± 2.5 years wear) have been enrolled into the study. All subjects attended the baseline visit having worn lenses for at least 6 h. Bulbar and limbal hyperaemia were graded on a scale of 0–100 in each quadrant. All subjects were then refitted with Focus Night&Day SH lenses; however, in order to reduce the potential for bias, they were informed that they were being randomly assigned to either wear low Dk lenses or to wear the SH lenses and would be unaware of lens assignment. Subjects returned for follow-up following 1 week, 1 and 2 months of daily wear. Lenses were replaced at the 1-month visit.

Results: Bulbar and limbal hyperaemia decreased significantly in all quadrants during the study. The reduction was most marked for the temporal and nasal limbal quadrants (>10 units, $P < 0.0001$) and was most apparent between the baseline and 1-week visits. Subjects reported a corresponding reduction in end of day redness and dryness and improved end of day comfort compared with their previous lenses.

Conclusion: Hyperaemia in contact lens wearers may be attributed to a number of factors including hypoxia. Refitting existing low Dk lens wearers with SH lenses on a daily wear basis can result in a decrease in hyperaemia which may be significant for some subjects.

Corneal thickness measurements using ultrasonic pachymetry and the Orbscan in keratoconic and normal subjects

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Purpose: The aim of this study was to compare the corneal thickness measurements obtained using ultrasonic (US) pachymetry with the Orbscan II in keratoconic and normal subjects.

Methods: Ninety-six eyes of 60 keratoconic patients who had varying degrees of keratoconus, underwent corneal topography using the Orbscan II (Bausch & Lomb Surgical, Rochester, NY). This was repeated on 31 normal subjects. Central corneal thickness (CCT) was measured in all the normal subjects using an ultrasonic pachymeter (PACSCAN 300, Sonomed, Clement Clark Inc., Lake Success, NY, USA). In the keratoconus group of patients the Orbscan map was used to locate the apex of the cone and apical thickness (AT) was measured, the CCT was also measured.

Results: The mean ultrasonic central thickness (UCT) and Orbscan central thickness (OCT) in normal subjects (mean age 31.52 ± 6.72) was 575 ± 49.41 and 606 ± 47.76 mm, respectively. With default correction OCT was 557 ± 43.96 mm. The UCT and OCT in the keratoconic group (mean age 30.83 ± 8.30 years) was 509 ± 83.50 and 427 ± 57.70 mm, respectively. The default correction factor reduced the OCT value to 396 ± 70.39 mm. In assessing the apical thickness in the keratoconic group using the US pachymeter (UAT) and the Orbscan (OAT), mean values of UAT 483 ± 76.54 and 401 ± 78.49 mm were obtained.

Conclusions: In keeping with previous studies, higher CCT were found using the Orbscan compared with the ultrasonic pachymeter in normal eyes. In keratoconic eyes Orbscan readings were up to 82 mm lower compared with the US pachymeter. A statistically significant difference was found between the two instruments. The Orbscan does not

provide reliable corneal thickness readings in cases of advanced keratoconus.

A 2-year retrospective study of the indications and success rates of different types of therapeutic contact lenses

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Purpose: To perform a clinical audit of the various reasons for, and types of, therapeutic contact lenses fitted in the Optometry Department of a major eye teaching hospital in the UK.

Methods: A review of the case notes of 75 consecutive patients referred to the contact lens department between November 2000 and November 2002, took place. The reason for referral, type of contact lenses fitted success of the contact lens and the improvement in vision was analysed.

Results: (a) The diagnosis at time of referral was keratoconus (57%), penetrating keratoplasty (13%), aphakia (12%), followed by trauma requiring cosmetic contact lens fitting (10%), intractable diplopia (3%), and others (5%). (b) The main type of contact lens design used was Kera I and II (31%), Rose K (17%) soft contact lenses, none of these were keratoconic (14.7%), Rose K post-graft (6.7%), Quasar K at 9% followed by other smaller groups. (c) Fifty-six percent of the contact lenses fitted at first attempt were 'successful' and tolerated with little difficulty. Thirty percent required further refits over the course of the 2 years for various reasons including progression of the condition in the case of keratoconus.

Conclusions: A variety of different contact lenses have been fitted in this tertiary referral centre for differing conditions. It is hoped that this detailed retrospective study will provide useful clinical information for short- and long-term management of this department and provide those interesting in developing further expertise in this areas, a more accurate clinical profile of likely patient types.

Baseline wearer-reported factors associated with development of corneal infiltrates with silicone hydrogel lenses for continuous wear: an interim report

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Purpose: To measure the association of baseline wearer-reported factors with the development of corneal infiltrates with continuous wear of lotrafilcon A lenses.

Methods: Wearers registered in the Focus Night&Day post-approval evaluation completed an extensive questionnaire on proposed risk factors for the development of complications from lens wear. Responses from wearers who developed a corneal infiltrate at any time since enrolment (event) have been compared with those wearers who have not developed corneal infiltrates (control) within the first 3 months of the study.

Results: Infiltrates were confirmed in 91 wearers; 5990 other wearers passed 3 months in the study without report of infiltrates. Factors significantly associated with the events were age <30, <25 and <20 years (odds ratio (OR) $= 1.6$, $P = 0.029$; 1.7, $P = 0.008$; 1.8, $P = 0.016$, respectively); report of never being married (OR $= 1.6$, $P = 0.024$), wiping hands instead of washing hands before lens handling (OR $= 6.3$, $P = 0.0002$). Swimming while wearing lenses showed a trend for association with events (OR $= 1.5$, $P = 0.08$). Being a new wearer to contact lenses was found to be protective (OR $= 0.3$, $P = 0.04$). Ninety-five percent confidence intervals will be shown.

Conclusions: These results indicate that age under 30 years, report of casual hand washing behaviour and swimming while wearing lenses may be associated with the development of corneal infiltrates with continuous wear of silicone hydrogel lenses. Counselling patients with these factors at the time of fitting about early symptoms of corneal inflammation may help prevent the development of these events.

The effect of contact lens wear on ocular surface temperature (BCLA DaVinci Award)

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Purpose: To examine dynamic temperature changes of the anterior eye with contact lens wear.

Methods: Forty-eight subjects (21.7 ± 1.9 years) had their ocular surface temperature measured with a non-contact, infrared camera (ThermoTracer TH7102MX) following a minimum of 2 h wear, and immediately following lens removal. Subjects wore: no lenses ($n = 8$ control); lotrafilcon A on a continuous (LCW; $n = 8$) or daily wear basis (LDW; $n = 8$); balafilcon A on a continuous (BCW; $n = 8$) or daily wear basis (BDW; $n = 8$); or etafilcon A on a daily disposable regimen (EDW; $n = 8$). All contact lens wearers had been wearing lenses for over 1 year. The dynamic ocular surface temperature profile was measured for 8 s continuously after a blink. Custom-designed software allowed dynamic quantitative objective analysis of the computerised thermal images.

Results: Ocular surface temperature immediately following contact lens wear was significantly greater compared to non-lens wearers ($35.5 \pm 1.1\,^{\circ}$C versus $37.8 \pm 0.9\,^{\circ}$C; $P < 0.01$), predominantly in the LCW group ($38.5 \pm 2.0\,^{\circ}$C; $P < 0.001$). However, there was no difference with modality of wear (DW $37.5 \pm 1.6\,^{\circ}$C versus CW $37.8 \pm 1.9\,^{\circ}$C; $P = 0.63$) or material (SiH $37.6 \pm 1.9\,^{\circ}$C versus etafilcon A $37.8 \pm 0.7\,^{\circ}$C; $P = 0.79$). Temperature on top of the lens was highly correlated ($r = 0.97$) to, but lower than ($-0.57 \pm 0.16\,^{\circ}$C) that beneath the lens. Ocular surface cool-

ing following a blink was not significantly affected by contact lens wear ($P = 0.32$).

Conclusions: Ocular surface temperature is greater with contact lenses in situ, regardless of lens material or modality of wear, probably due to the thermal insulating properties of a contact lens. Increased eye temperature has been implicated in bacterial binding, dry eyes and inflammation and hence this new technique offers great potential for clinical monitoring of ocular physiology.

The development of a disposable ophthalmic barrier system to prevent cross-infection from contact ophthalmic devices—an update

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It is generally accepted that there is a potential risk of cross-infection from contact ophthalmic devices. Examples of cross-infection include: (a) herpes simplex; (b) adenovirus; (c) prions and theoretically CJD transmission; and (d) HIV. The current methods used to prevent this cross-infection are either inefficient or not cost effective and have limited applications, e.g. tonometer heads and silicone sheaths. Most commonly the contact areas of these ophthalmic devices are sterilised by wiping with an alcoholic swab, but this is inadequate and ineffective. It is proposed that the disposable barrier system is universal, meaning that the system can be applied to several types of ophthalmic contact devices including the Goldman tonometer, Gonioscope lenses and A-scan ultrasound probes of the eye. The properties of a successful universal disposable barrier film are: (a) disposable; (b) reversible adhesive layer; (c) optically transparent; (d) small mass to avoid recalibration of the ophthalmic device; (e) non-permeable barrier film; and (f) compatible barrier film with the tear film. A four-layer barrier system prototype is currently being developed and undergoing clinical trials. This four-layer barrier system consists of a barrier film, which is coated with an adhesive hydrogel. Protective liners maintain the adhesive layer and barrier film sterility until the device is used. An indication of the fabrication technology and results from initial clinical evaluation will be presented.

Refractive outcome and corneal response to a customised esa-curve reverse-geometry lens designs for overnight orthokeratology

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Purpose: We have developed and patented a new design and calculation method to customise a multi-curve reverse geometry lens. This new design is based on a biconic model on which we developed an esa-curve customised reverse geometry lens design. A prospective, randomised study was performed to evaluate the efficacy and safety of corneal reshaping with this overnight orthokeratology contact lens design. All the lenses were in siloxy-fluoromethacrylate Dk 100 gas-permeable material (hexafocon A).

Methods: Fifty eyes of 25 myopic patients aged from 11 to 44 years were treated. All the subjects with a mesopic pupil diameter larger then possible BOZD where excluded. The baseline refractive error was from −1.00 to −6.00 D spherical equivalent, WTR astigmatism up to 1.50 D and ATR or oblique astigmatism up to 0.75 D. Subjective rating, unaided visual acuity, subjective refraction, best-corrected visual acuity, pupillometry, corneal topography, corneal wavefront analysis, and biomicroscopic data were collected. Visits included baseline, dispensing, 1 day, 1 week, 1 and 3 months after lenses were worn. For all the subjects an overnight wear was scheduled. After overnight wear, data were collected in the morning immediately following lens removal and 12 h after lens removal.

Results: The cornea responds rapidly with significant ($P < 0.05$) central corneal flattening and improvement in visual acuity after just 60 min of lens wear; the corneal shape changes from prolate to oblate asphericity after one night of wear; in the majority of cases improvement in unaided visual acuity up to 0.1 logMAR can be obtained for at least 12 h after lens removal in the first week of treatment. These changes were sustained at 1 and 3 months. In the first week, there was a significant improvement in subjective ratings of quality of day and night vision ($P < 0.05$) but a significant increase of corneal spherical aberration ($P < 0.05$) due to post-treatment oblate shape of the cornea. Subjective ratings continued to improve after objective measures stabilised at 1 week. No significant ocular adverse events were observed during the trial.

Conclusions: The preliminary results of this study suggest that the corneal epithelium is able to be moulded or redistributed very rapidly in response to the tear film forces generated behind this reverse-geometry lens design. Safety and efficacy of the procedure appear to be favourable without significant adverse reactions; however, future studies are needed to determine the more long-term outcomes of treatment.

Co-management in refractive surgery

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Many patients will express an interest in exploring the possibilities that refractive surgery can offer and will require advice on what it involves and its likely success rate from them. Patients who discuss their desire to undergo refractive surgery procedures with their own optometrist often report comments from their optometrist such as ‘laser surgery is still experimental’ or ‘the results are not stable’. Usually optometrists that dismiss refractive surgery are those who are ill-informed about current techniques. At the very least op-

tometrists should be aware of the type of surgery that is available in their local vicinity and to obtain an idea of the results being achieved, especially nowadays that refractive surgery has found a firm foothold as an alternative to optical aids. Those with more of an interest may already be involved in a 'shared-care' type co-management scheme with a local refractive surgeon or refractive surgery centre. Recognition of the basic skills and training received by optometrists has lead to various types of co-management schemes that are deemed within the realm of optometrists. Many schemes deal with pathological abnormalities of the eye such as cataract, diabetes, glaucoma and low vision aids. This talk deals with the implications of co-management schemes that exist in refractive surgery and the position of various professional bodies regarding these schemes. Financial implications of refractive surgery, legal implications of co-management schemes and details of professional indemnity will be discussed. Sources of information that are used by clinicians and patients will be highlighted. Results of surveys looking at market trends in refractive surgery in the UK and internationally will be mentioned to show patterns of growth that may help to predict future trends.

The need for refractive surgery in naval aviation

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Safe correction of refractive error in the aviation population has long been a concern. Optical appliances for correcting refractive errors and/or presbyopia are worn by up to 39% of pilots and 63% of navigators. Technologic advancements over the last several decades have resulted in more sophisticated and specialised weapon systems and headgear. Night vision goggles (NVGs), helmet mounted targeting sights, and chemical/biologic protective headgear are a few examples of the equipment commonly used in today's forces. They all share a level of incompatibility with spectacles. Spectacle lenses fell out of their frame in 22% of aircrew during flight in a 1995 USAF vision survey. Reports on the use of contact lenses (CL) in pilots in desert shield/storm indicated that approximately 45% of aircrew who wore contact lenses while flying lost or misplaced a lens while airborne. The latest generation of night vision goggles can weigh several pounds. NVGs are currently being worn by almost every community of aviators, from strike fighters to helicopters. Wearing spectacles while using NVGs is a known hindrance and a possible safety of flight issue due to the ergonomics of properly fitting NVGs combined with spectacles.

Because of numerous medical and operational difficulties, contact lenses offer only a partial solution to correct ametropia. Only 60–70% of aviators are able to be fitted and successfully wear CL on a long-term basis. There are well known medical risks of CL, such as bacterial keratitis and giant papillary conjunctivitis. Operationally, hard contact lenses can dislodge while manoeuvring under positive acceleration, form gas bubbles underneath the lens during low atmospheric pressure, and require a prolonged adaptive period. The most significant operational problem with soft contact lenses (SCL) is intolerance. This is most likely to occur when the humidity is low and/or there is a high amount of particulates in the air, such as in a hot, dusty environment. This was a significant problem in desert shield/storm. There are also logistics problems; solutions and replacement lenses can be difficult to attain while deployed.

Corneal topography, aberrations and vision

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Over the years, I have had the privilege of working in three fine optometry programs at The University of Melbourne, The Ohio State University and Queensland University of Technology, all of which have fostered and encouraged excellence in research. I have been fortunate to work and study with a great many leading researchers and educators, and I am an ardent believer in the need for strong collaborative, and often multi-disciplinary, approaches to today's research questions. The work behind this BCLA Medal presentation relies on expert input from optometry, ophthalmology, physics, engineering, mathematics and more.

For the past 13 years, one of my roles has been to lead the vision research unit at QUT (http://www.hlth.qut.edu.au/opt/). This research group is diverse in its expertise and in its interests, but two particular emphases are on visual optics and refractive error research, and on applied vision problems. The emphasis on visual optics, and in particular retinal image formation, image quality assessment and the relationship to visual performance, is relevant to my own research interests, and the implications of this work for refractive error development and control have added a new and perhaps unexpected dimension to the research.

While much of my research has been broadly about contributing to our understanding of the structure and function of the anterior eye, under both normal and abnormal conditions, contact lens studies have always played an important role in this research for two reasons. Firstly, of course, contact lenses are a major modality in their own right for the correction of refractive errors and improvements in contact lens utilisation are of importance to all of us. But secondly, contact lenses represent perhaps the most common of all optical and physiological challenges to normal corneal functioning.

There have been a number of themes to this research, including effects on corneal physiological function, effects on visual performance, and contact lens design. But one of the enduring themes which has been present since my postgraduate studies is that of corneal topography and its relationship to contact lens wear and visual func-

tion, and it is this topic which will be addressed in this presentation.

The field of corneal topography and its applications has changed dramatically in recent years. While the measurement of corneal topography has been an accepted scientific and research endeavour for well over a century, it is only since the adoption of commercially produced and user-friendly instrumentation that its value in vision care has become widely appreciated. Its measurement is now a major interest of the optical industry, and it influences not only contact lens design and contact lens fitting, but also surgical interventions in corneal optics and vision.

However, while the collection of data on corneal shape is now quicker, easier and more accurate than ever, the interpretation of that data and the analysis of its relevance to visual functioning has become more complex and more difficult with time.

The cornea is the major contributor to the optical properties of the eye and to the total wavefront aberrations of the eye, and its accessibility has made it an attractive option for creating changes or improvements in visual performance. Image reconstruction techniques can allow us to better understand the effects of aberrations on human vision, and the effects of changes in those aberrations on retinal image quality. Through the use of sophisticated measurement and analysis techniques, the prospects of successfully incorporating corneal or contact lens corrections based on topographical and optical analyses can be better evaluated.

The ocular surface and contact lens wear

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Dry eye is a very prevalent condition in the normal population, and its management remains a challenge to practitioners. This challenge often becomes even greater when contact lens wear is added to the situation.

However, there is sound information on the causes of this problem, and this knowledge can offer insights into best management strategies with and without contact lens wear. In particular for contact lens wearers, the critical role of the ocular surface in tear layer disturbances is now established and should be considered when management strategies are being formulated.

Satisfactory management of patients with ocular surface changes and tear layer disturbances, including marginal dry eye, remains difficult. But improvements in contact lenses, including both materials and designs, and the full and correct interpretation of the underlying causes of the problem, offer improved prospects for its successful management.

Where are we with wavefront in refractive surgery?

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Wavefront-guided laser treatments were initially promoted to provide supernormal vision. However, after 5 years of experience the hype has come to a realistic base line. Today, wavefront-guided treatments have their clinical relevance mainly in treating eyes with higher order aberration above average. Patients that suffer from glare and halos under mesopic conditions or patients with extreme irregular astigmatism after an initial treatment will benefit at most from customized ablations. In particular, re-treatments after an initial LASIK or PRK were found to be significantly better when the outcomes are compared to the results of re-treatment performed with “classical” ablation.

Corneal refractive surgery

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The anterior surface of the cornea, more specifically the air/tear film interface, is responsible for 60 to 70% of the optical power of the eye. Because the shape of the cornea so profoundly affects the refractive state of the eye, many forms of refractive surgery attempt to alter its convex curvature. Myopia can be treated by increasing the central radius of curvature, making the cornea flatter with less optical power. Hyperopia treatment would be just the opposite: decrease the radius of curvature to increase the optical power. Notable exceptions are various implants that have a higher index of refraction than does the corneal stroma (intrastromal implant). These implants rely on their intrinsic curvature to determine refractive correction. Refractive surgery has exploded in popularity over the last 10 years, due in a large part to the success of laser in-situ keratomileusis (LASIK). This procedure has almost singlehandedly created an ophthalmology subspecialty. Millions of LASIK procedures have been performed in the US alone. Because of its success, the bar has been raised on evaluating outcomes. Whereas an outcome of 20/40 uncorrected vision was considered a success in the days of radial keratotomy, reporting a high percentage of patients with 20/20 vision is now expected for the treatment of low myopia. It is no longer meaningful to define efficacy as the percent of eyes within 2.0D of intended correction. Even the percent of eyes within 1.0D has been inadequate to describe the improved accuracy of current laser systems to correct low myopia. Because of the success of LASIK, patient expectations have risen as well. To meet these expectations and expand market share, improvements in design and technique are continually being sought by manufacturers and clinicians. This has included other forms of refractive surgery, such as LASEK, corneal ring segments, and conductive keratoplasty.

Intraocular refractive surgery

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Intraocular refractive surgery has become an important part of modern refractive surgical procedures. Intraocular refractive surgery can be approached with phakic IOLs and refractive lens exchange, with or without a previous cataract. Important and significant advances have been achieved during the last five years in phakic IOL design and scientific knowledge on the optical performance of intraocular lenses when implanted in high emmetropia. Refractive lens exchange has improved its results and is facing a very promising future with emerging technologies for cataract/lens removal and new intraocular lenses implantable through microincisions (MICS, sub 1.5 mm incisions) or intralenticular materials that could be molded after being injected inside the capsular bag. This lecture will approach the perspectives that today refractive surgery has on intraocular refractive surgical procedures.