
In September 2010, a Symposium in Florence, Italy, was held to address the unmet need for global treatments for dry eye disease (DED). It was sponsored by The Tear Film & Ocular Surface Society (TFOS; www.TearFilm.org) and co-sponsored by the Association for Research in Vision & Ophthalmology (www.arvo.org). The Symposium objectives were two-fold: first, to discuss accepted and emerging clinical endpoints of DED with regulatory experts from around the world; and second, to consider how to improve clinical trials of treatments for DED. The Symposium focused on the personal and collective burden of DED, as well as the developmental and regulatory challenges associated with generating new DED therapeutics. This article provides a synopsis of many of the presentations, discussions and recommendations of this Symposium. Copyright © 2012 Elsevier Inc. All rights reserved.


OBJECTIVE: To develop and validate a comprehensive patient-reported outcomes instrument focusing on the impact of dry eye on everyday life (IDEEL).

METHODS: Development and validation of the IDEEL occurred in four phases: 1) focus groups with 45 dry eye patients to develop a draft instrument, 2) item generation, 3) pilot study to assess content validity in 16 patients and 4) psychometric validation in 210 subjects: 130 with non-Sjögren's keratoconjunctivitis sicca, 32 with Sjögren's syndrome and 48 controls, and subsequent item reduction.

RESULTS: Focus groups identified symptoms and the associated bother, the impact of dry eye on daily life and the patients' satisfaction with their treatment as the central concepts in patients' experience of dry eye. Qualitative analysis indicated that saturation was achieved for these concepts and yielded an initial 112-item draft instrument. Patients understood the questionnaire and found the items to be relevant indicating content validity. Patient input, item descriptive statistics and factor analysis identified 55 items that could be deleted. The final 57-item IDEEL assesses dry eye impact constituting 3 modules: dry eye symptom-bother, dry eye impact on daily life comprising impact on daily activities, emotional impact, impact on work, and dry eye treatment satisfaction comprising satisfaction with treatment effectiveness and treatment-related bother/inconvenience. The psychometric analysis results indicated that the IDEEL met the criteria for item discriminant validity, internal consistency reliability, test-retest reliability and floor/ceiling effects. As expected, the correlations between IDEEL and the Dry Eye Questionnaire (a habitual symptom questionnaire) were higher than between IDEEL and Short-Form-36 and EuroQoL-5D, indicating concurrent validity.
CONCLUSION: The IDEEL is a reliable, valid and comprehensive questionnaire relevant to issues that are specific to dry eye patients, and meets current FDA patient-reported outcomes guidelines. The use of this questionnaire will provide assessment of the impact of dry eye on patient dry eye-related quality of life, impact of treatment on patient outcomes in clinical trials, and may aid in treatment effectiveness evaluation.


PURPOSE: To study the effect of extrinsic controls on blinking by examining blink parameters and tear stability among adapted soft contact lens (CL) wearers performing tasks that require varying amounts of visual concentration.

METHODS: The Demographic Questionnaire, Contact Lens Dry Eye Questionnaire, and Current Symptoms Questionnaire were completed by 15 adapted soft CL wearers (nine females). Three 55 s simultaneous measurements of tear film stability via retroillumination and blinking were obtained with a slit-lamp biomicroscope and 200 Hz video camera while subjects listened to music and played a video game with and without their habitual CLs. Interblink interval (IBI) and blink amplitude (BA) were calculated. The area of break-up (AB) was calculated for the retroillumination image before each blink. The Current Symptoms Questionnaire was completed four times throughout testing.

RESULTS: With the game compared to music, IBI was significantly longer and BA significantly decreased without CLs (p < or = 0.001). With CLs, the IBI did not significantly change between tasks but the BA significantly decreased (p = 0.100). The AB significantly increased with CL and the game (paired t-test, p < or = 0.001). The BA was significantly correlated with self-reported severity of dry eye for all testing scenarios (Spearman r > or = 0.5579, p < 0.0001) and several symptom measures (Spearman r > or = 0.6262, p < 0.0001). The AB was significantly correlated with symptom measures including bothersome discomfort for the game with and without CLs (Spearman r > or = 0.5064, p < 0.0001).

CONCLUSIONS: During tasks requiring concentration, the IBI increased (blink rate decreased) and many blinks were incomplete without CLs. With CLs, tear film instability increased. Blinking frequency also increased, but it remained high when subjects played the game, and symptoms of ocular irritation increased. This suggests that wearing soft CLs, even when fully adapted, provides enough extrinsic ocular surface stimulation to override internal controls and affect blink parameters.


PURPOSE: To compare changes in optical quality and visual performance that accompany tear break-up (TBU) during blink suppression.

METHODS: A three-channel optical system was developed that simultaneously measured refractive aberrations (Shack-Hartmann aberrometer), 20/40 letter contrast sensitivity (CS), and TBU (retroillumination, RI). Ten wearers of silicone hydrogel
Contact lenses were asked to keep one eye open for approximately 18 seconds, while CS, wavefront aberrations, and RI images were collected. The wavefront was reconstructed by zonal methods, and image quality was quantified with a series of metrics including RMS fit error. Novel metrics for quantifying TBU over the contact lens surface were developed by quantifying the contrast of the RI image and by using Fourier descriptors of the first Purkinje (PJ) image shape.

RESULTS: There was a full range of TBU over the lens surface, with four subjects showing TBU across the corneal center and one subject with TBU in the inferior peripheral pupil. Among the four subjects with central corneal TBU, RMS fit error, RI contrast, and PJ Fourier descriptors showed high correlation with CS (r² range, 0.9187-0.9414, 0.6261-0.975, and 0.4917-0.8986, respectively). Some of the general optical-quality metrics such as blur strength, neural sharpness, and area of modulation transfer function (MTF) also showed that change correlated with CS loss.

CONCLUSIONS: Optical metrics of tear quality and retinal image quality are associated with the decline in vision that occurs with TBU. The evidence supports the hypothesis that blurry vision symptoms reported by contact lens wearers are caused by poor quality of the retinal image due to TBU.


PURPOSE: To validate a subset of Dry Eye Questionnaire (DEQ) items that discriminate across self-assessed severity and various diagnoses of dry eye (DE).

METHODS: Subjects (n=260) in 2 studies received a clinical DE diagnosis, completed the 6-page DEQ and self-assessment of DE severity (SA-Sev). SA-Sev ratings were: 46 Severe, 107 Moderate, 77 Mild, and 46 None. Dry eye diagnoses were: 48 asymptomatic controls (C), 155 non-SS KCS, and 57 Sjögren Syndrome (SS). All DEQ items were correlated to SA-Sev by Spearman. Groups of highly correlated DEQ items were tested to discriminate SA-Sev; and the subset tested to distinguish across DE diagnosis.

RESULTS: The DEQ-5 comprises: frequency of watery eyes (r=0.48), discomfort (r=0.41), and dryness (r=0.35), and late day (PM) intensity of discomfort and dryness (r=0.42, 0.36) all significantly correlated to SA-Sev (p<0.01). Mean DEQ-5 scores by SA-Sev: Severe 14.9+/—2.3, Moderate 11.4+/—3.3, Mild 8.6+/—3.1 and None 2.7+/—3.2 (ANOVA, p<0.0001) and by DE diagnosis: C 2.7+/—2.9, non-SS KCS10.5+/—4.5 and SS14.0+/—3.4, differing significantly overall (Z=—8.6, p=0.000) and between diagnoses (Χ²=116.3, p=0.000). Watery eyes were reported primarily by non-SS KCS. Proposed screening criteria for the DEQ-5 are >6 for DE and >12 for suspected SS.

CONCLUSIONS: The DEQ-5, the sum of scores for frequency and PM intensity of dryness and discomfort plus frequency of watery eyes, effectively discriminated across self-assessed severity ratings and between patients with DE diagnoses. These results indicate that DEQ-5 scores >6 suggest DE and scores >12 may indicate further testing to rule out SS-DE. 2009 British Contact Lens Association. Published by Elsevier Ltd. All rights reserved.

PURPOSE: To assess the effects of gender and hormone status on the severity and progression of keratoconus in patients enrolled in the Collaborative Longitudinal Evaluation of Keratoconus Study.

METHODS: The severity and progression of keratoconus in both men (M) and women were evaluated over a 4-year period that encompassed menopausal transition for hormone-active women (HA) and hormone-inactive women (HI). Four outcome measures were selected as indicators of the severity of keratoconus: high-contrast best-corrected visual acuity, low-contrast best-corrected visual acuity, the steep keratometric measurement, and corneal scarring (yes/no).

RESULTS: There were no statistically significant differences among the 3 groups (M, HA, and HI) in race, history of atopic disease, family history of keratoconus, or rigid contact lens wear in the right and left eyes. At baseline, there were no significant differences among the 3 groups in high-contrast best-corrected visual acuity, low-contrast best-corrected visual acuity, or steep keratometric reading. Progression of keratoconus, as assessed by changes in these 3 continuous variables, was equal for the 3 groups. M had more corneal scarring than did HA or HI; however, there was no progression of scarring for any of the groups.

CONCLUSION: Keratoconus progressed in both men and women, aged 48-59 years; however, there were no differences among the groups in progression.


PURPOSE: Tear film instability and tear hyperosmolarity are considered core mechanisms in the development of dry eye. The authors hypothesize that evaporation and instability produce transient shifts in tear hyperosmolarity that lead to chronic epithelial stress, inflammation, and symptoms of ocular irritation. The purpose of this study was to provide indirect evidence of short-term hyperosmolar conditions during tear instability and to test whether the corneal epithelium responds to transient hyperosmolar stress.

METHODS: Five subjects kept one eye open as long as possible, and overall discomfort and sensations associated with tear break-up were scaled. Later, the same subjects used the same scales to report discomfort sensations after instillation of NaCl and sucrose hyperosmolar drops (300-1000 mOsM/kg). A two-alternative, forced-choice experiment was used to obtain osmolarity thresholds. In the second experiment, primary cultured bovine corneal epithelial cells were transiently stressed with the same range of hyperosmolar culture medium, and proinflammatory mitogen-activated protein kinase (MAPKs) were measured by Western blot analysis.

RESULTS: Tear instability led to an average discomfort rating of 6.13 and sensations of burning and stinging. These sensations also occurred with hyperosmolar solutions
(thresholds, 450-460 mOsM/kg) that required 800 to 900 mOsM/kg to generate the same discomfort levels reported during tear break-up. MAPK was activated at 600 mOsM/kg of transient hyperosmolar stress.

CONCLUSIONS: These experiments provide a link between hyperosmolarity and tear instability, suggesting that hyperosmolar levels in the tear film may transiently spike during tear instability, resulting in corneal inflammation and triggering sensory neurons.


PURPOSE: This study investigates the relationship between blinking, tear film break-up, and ocular symptoms for normal and dry eye subjects performing four different visual tasks.

METHODS: Sixteen control and sixteen dry eye subjects performed four visual tasks (looking straight ahead, watching a movie, identifying rapidly changing letters, and playing a computer game) while blink patterns and fluorescein images of the tear film were videotaped. Pre and posttesting symptom questionnaires, querying the intensity of nine symptoms of ocular irritation, were completed by all subjects. Blink rate and blink amplitude were computed from digitized videos. The percentage of tear film break-up before the blink was calculated.

RESULTS: Dry eye subjects had a significantly higher blink rate ($p = 0.017$, t-test). Both groups blinked significantly less during the game and letter tasks ($p < 0.04$, t-test). Partial blinks were common as were clusters or "flurries" of rapid blinks, but there was no significant difference in blink amplitude for control and dry eye subjects. Tear film break-up in normal subjects was typically inferior; whereas dry eye subjects showed more tear break-up centrally and superiorly. Real-time video recording of tear break-up and blink behavior pointed to complex interaction between the two. Dry eye subjects shifted more toward intense ocular symptoms at posttesting ($p < 0.05$, Wilcoxon signed rank) than controls. Both groups showed a shift toward more corneal staining at posttesting ($p < 0.05$, Wilcoxon signed rank), which was typically inferior.

CONCLUSIONS: Reduced and incomplete blinking along with increased tear film break-up during normal visual tasks may explain the increased level of ocular discomfort symptoms reported at the end of the day, particularly in dry eye patients.


PURPOSE: To determine if the discomfort associated with pterygium is different for men and women.

METHODS: Subjects were selected from patients attending a clinic in Guanajuato, Mexico, which has a high prevalence of pterygium. Discomfort was determined using a Spanish version of an English questionnaire designed to evaluate symptoms in dry eye patients. Questions were asked regarding seven sensations of discomfort, and five environmental sources of irritation that were not present in the original questionnaire: smoke, cigarette smoke, dust, wind, and sun. Most of the subjects had limited reading skills so the questionnaire was administered orally. Two subsamples are reported. In
the first subsample, the interviewer was a male interviewer and the subsample was made up of 28 matched pairs of subjects selected from a total of 110 subjects (one man and one woman in each pair with the same age and pterygium stage). In the second subsample, the interviewer was a female interviewer and made up of 16 matched pairs selected from a total of 70 subjects. Pterygium staging was based on a scale in which progression was staged on a scale of one to five. The data was analyzed statistically using the Mann-Whitney U test (two-tailed).

RESULTS: The subjects had an age range of 41 to 82 years. The pterygium stages ranged from localized minor disturbances of the nasal conjunctiva (one on the scale) to compound pterygium (five on the scale). The difference in ocular surface discomfort between men and women was statistically significant for both the male interviewer (P < 0.001) and the female interviewer (P < 0.01).

CONCLUSIONS: Women with pterygium report more discomfort than men. It is likely that men and women with other sources of ocular surface discomfort also respond differently to pain.


PURPOSE: To determine dryness symptoms attributable to hydrogel contact lens (HCL) wear by comparing symptoms from age-matched HCL wearers and non-wearers in a cross-sectional study, and to compare that difference to the change in proportion of subjects reporting frequent dryness among HCL wearers after refitting with lotrafilcon A or B silicone hydrogels (SHCLs).

METHODS: Prevalence of frequent dryness symptoms was compared between HCL and non-wearers from a cross-sectional, historical dataset of Dry Eye/Contact Lens Dry Eye Questionnaires using an age-matched subset of 259 HCL and 246 non-wearers. Prospective change in prevalence of frequent dryness from non-randomized studies (n = 1036), in which daily wear (DW) HCL wearers were refit with lotrafilcon A or B SHCLs, was then compared to the cross-sectional difference between HCL wearers and non-wearers.

RESULTS: In the Dry Eye/Contact Lens Dry Eye Questionnaires dataset, 47% fewer non-wearers reported frequent dryness than HCL wearers (p = 0.0001). In the lotrafilcon A DW refitting trials, frequent dryness was reported by 67 and 62% fewer subjects for during the day (DD) and end of the day (EOD) dryness (p = 0.0001, both) after refitting. In continuous wear lotrafilcon A trials, there were 63 and 41% reductions in the proportion reporting frequent DD and EOD dryness (p = 0.014 and p = 0.02). Refitting to DW lotrafilcon B yielded a 48 and 46% reduction in the number of subjects reporting frequent DD and EOD dryness (p < 0.0001, both).

CONCLUSIONS: After refitting DW HCL wearers with either lotrafilcon A or B SHCLs, the proportion of symptomatic wearers was approximately half; an amount similar to the difference in proportion between HCL and non-wearers. This raises the possibility that refitting HCL wearers with SHCLs eliminates the component of dryness that is induced by HCL wear. Further research with more robust experimental design is recommended to test this hypothesis.

PURPOSE: This study was to investigate the role of the upper meniscus in tear film formation and blinking.

METHODS: One microliter of 2% fluorescein was instilled under the upper lid of 15 dry eye (DE) and 15 control subjects. Subjects were instructed to blink partially and hold the eye open as long as possible, and analysis of tear breakup dynamics was used to quantify the area of breakup. This procedure was repeated following a full blink. Meniscus height was measured from digital videos.

RESULTS: Both menisci were significantly decreased in DE compared with controls (p < 0.02, t test). Tear breakup dynamics analysis showed that significantly greater areas of breakup occurred with full compared with incomplete blinks in DE (p < 0.003 Mann Whitney U test), but not in controls.

CONCLUSIONS: A stable tear film can be deposited by the upper meniscus alone following a partial blink, without contribution from the lower meniscus. The increased tear stability of partial blinks in DE may be due to less stretching of the already fragile tear film compared with a full blink, which covers more surface area.

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PURPOSE: The impact of dry eye on everyday living (IDEEL) is a valid, reliable questionnaire with 3 modules; symptom bother (SB), quality of life, and treatment satisfaction. This study tests the utility of the 20-item IDEEL-SB to discriminate self-assessed severity in dry eye subjects and to determine the clinically important difference (CID) in IDEEL-SB score that relates to a self-report of global change in dry eye condition after treatment.

METHODS: After randomization to 1 of 3 marketed tear replacements, dry eye subjects completed the IDEEL-SB at baseline, 1 and 4 wk and global change questionnaire on status of general health and dry eye at 1 and 4 wk (5-point Likert scale; "much better" to "much worse"). The IDEEL-SB score was the unweighted mean score x 25. CID was initially estimated by receiver-operator curve analysis (ROC) and global change questionnaire. Various IDEEL-SB change criteria were tested to maximize % agreement, kappa score, and effect size.

RESULTS: The 74 subjects were 54.0 +/- 17.2 years old and 52 (70.3%) were female. At baseline, 56.3% rarely/never used replacement tears. Subjects rated their dry eye severity as mild (41%), moderate (50%), or severe (9%). IDEEL-SB discriminated dry eye severity well; average baseline scores were mild: 40.0 (SD = 7.5), moderate: 50.6 (SD = 11.0) and severe 64.3 (SD = 8.0) (p = 0.001). After 4 wk of drops usage, IDEEL-SB dropped among "improved" subjects by -13.3 (SD = 10.9), "same" shifted by -4.7 (SD = 9.4), "worsened" changed by 1.4 (SD = 11.1). ROC results show that a 12-point change in IDEEL-SB is a clinically significant change in symptoms.
CONCLUSIONS: 12-Point shift in the IDEEL-SB module is a CID based on ROC and the distribution across self-assessed severity groups compared with their global assessment of change in condition with treatment.


PURPOSE: This study used image analysis to compare the temporal progression and spatial reoccurrence of the area of tear film breakup (AB) in dry eye and normal subjects.

METHODS: Tear breakup was induced in 10 control and 10 dry eye subjects during the Staring Tear Breakup Dynamics (S-TBUD) test, which involves keeping one eye open for as long as possible, termed the maximum blink interval (MBI). Video imaging of tear film fluorescence measured the onset and progression of the AB. AB location and area were mapped. The progression of ABs from the first trial, the rate of tear breakup or dry area growth rate (DAGR), and the overlap of ABs in three successive trials 5 minutes apart were computed by custom MATLAB programs.

RESULTS: The final AB before the blink was significantly greater (average, 30.7%+/−12.5% vs. 16.1%+/−9.2%) and the MBI was significantly less (average, 19.5+/−9.0 seconds vs. 56.5+/−38.9 seconds) among dry eye subjects compared with controls (p<0.05, Mann-Whitney U test). The DAGR was four times greater among dry eye subjects, who also showed significantly more tear breakup in the central cornea than controls (p<0.0001, Mann-Whitney U test). When the final image from three successive trials was overlapped, tear breakup occurred more often in the same location in three trials than would be expected by the overlap of independent points.

CONCLUSIONS: Structural influences such as the "black line" or corneal lid defects appeared to influence the recurrence of breakup in the same region. The S-TBUD quantitative image analysis technique demonstrates that the tear film of subjects with dry eye continues to rapidly destabilize after an initial first break; thus, a low TBUT was combined with a high DAGR. The central corneal region of subjects with dry eye appeared especially susceptible to increased tear breakup when compared with controls.


Dry Eye Questionnaire (DEQ) and Contact Lens Dry Eye Questionnaire (CLDEQ) from unselected eye care patients (including current, former and non-contact lens wearers) were analyzed to contrast dryness symptoms among patients with and without contact lenses. Contact lens wearers reported a higher incidence of intense symptoms, especially late in the day (12.7% AM versus 41.1% PM, p < 0.0001), that diminished when they removed lenses (p = 0.0001). Dryness intensity was not correlated with gender and was inversely correlated with age among contact lens wearers, differing
significantly from the pattern among non-lens wearers. Contact lens related dryness differs from dry eye among non-lens wearers.


PURPOSE: The purpose of this study was to develop a novel, quantitative measurement of tear film breakup dynamics (TBUD) to study the phenomenon of tear breakup in dry eye and control subjects and its impact on dry eye symptoms.

METHODS: Ten control and 10 dry eye subjects completed the Dry Eye (DEQ) and other questionnaires. After the instillation of sodium fluorescein, subjects kept the tested eye open for as long as possible, similar to a staring contest, while tear film breakup was videotaped (S-TBUD). The maximum blink interval (MBI) and tear breakup time (TBUT) were measured from digital movies by a masked observer. Individual frames of movies were converted to gray-scale images, maps of relative tear film fluorescence were generated, and the total area of tear breakup (AB) of the exposed cornea was quantified.

RESULTS: On average, dry eye subjects demonstrated a higher AB and shorter TBUT and MBI, but only the AB was significantly different (p = 0.023). Subjects most often used the descriptors stinging and burning to describe their sensations during staring trials. The AB showed a high correlation between eyes and with some DEQ symptom measures.

CONCLUSIONS: These methods allow objective quantification and tracking of the phenomenon of tear breakup. Our results suggest that tear breakup stresses the corneal surface, resulting in stimulation of underlying nociceptors. The tear film of dry eye subjects was less stable than controls. They had a larger AB measured from the last video frame before MBI (i.e., just before blinking) than did controls. This perhaps reflects adaptation to the repeated stress of tear instability in dry eye.


PURPOSE: The purpose of this analysis was to measure the degree of agreement between clinicians' assessment and subjects' self-assessment of dry eye severity in a cross-sectional, observational dry eye study. A secondary purpose was to identify the role of gender and age in that concordance.

METHODS: In a cross-sectional observational study, 162 dry eye subjects and 48 controls were recruited from clinical databases of ICD-9 codes in 6 clinical sites. Before examination, subjects gave a global self-assessment of the severity of their dry eye from "none" to "extremely severe." After a clinical examination that included dry eye tests, the clinician discussed the subjects' symptoms and then gave global clinician assessment of dry eye from "none" to "severe." We measured the degree of agreement in these global measures.
RESULTS: Although the correlation and agreement between clinician and self-assessment was significant ($r = 0.720$, $P = 0.000$; weighted $K = 0.471$; 95% CI = 0.395, 0.548; $P = 0.000$), the clinician assessment underestimated the severity in 40.9% of the subjects by at least 1 grade compared with the subjects' self-assessment. Over 54% of subjects over age 65 and 43% of the female subjects had their condition underestimated by the clinician ($P < 0.05$).

CONCLUSIONS: Clinicians often relatively underestimated the severity of the subjects' self-assessment of dry eye in this clinical study, especially among the elderly and women. Eye care practitioners need better, more quantitative tools for the assessment of ocular surface symptoms to improve the concordance in severity assessment and to meet the needs of this symptomatic patient population by offering them appropriate treatments.


OBJECTIVE: The purpose of this study was to compare the discriminative properties of two generic health-related quality of life (QoL) instruments (SF-36 and EQ-5D) and a newly developed disease-specific patient-reported outcomes instrument (Impact of Dry Eye on Everyday Life (IDEEL)) to distinguish between different levels of dry eye severity.

METHODS: Assessment of 210 people: 130 with non-Sjogren's Keratoconjunctivitis Sicca (non-SS KCS), 32 with Sjögren's Syndrome (SS) and 48 controls; comparison of SF-36, EQ-5D, and IDEEL age-adjusted data by dry eye severity levels. Severity was assessed based on diagnosis (non-SS KCS, SS, control), patient-report (none, very mild, mild, moderate, severe, extremely severe) and clinician-report (none, mild, moderate, severe).

RESULTS: Discriminative validity results were consistent for all instruments. Significant differences between severity levels were found with most SF-36 scales ($P < 0.05$), all EQ-5D scales ($P < 0.05$), and all IDEEL scales ($P < 0.0001$), except for Treatment Satisfaction. IDEEL scales consistently outperformed the generic QoL measures regardless of the severity criterion used. Most SF-36 scales outperformed the EQ-5D QoL scale, but the EQ-5D visual analog scale outperformed the SF-36 scales, except for General Health Perceptions.

CONCLUSIONS: The disease-specific IDEEL scales are better able to discriminate between severity levels than the majority of the generic QoL scales. Preliminary evidence demonstrates that the IDEEL will be sensitive to QoL changes over time, although further testing in controlled longitudinal studies is needed.

PURPOSE: To assess the relative burden of dry eye in daily life by comparing Short Form-36 (SF-36) responses from individuals with and without dry eye against U.S. norms. METHODS: Assessment of 210 people, 130 with non-Sjogren's keratoconjunctivitis sicca (non-SS KCS), 32 with Sjogren's Syndrome (SS), and 48 control subjects. The study population data and published normative SF-36 data were compared. Dry eye severity was assessed by recruited severity (control, non-SS KCS, SS), patient self-report (none, very mild/mild, moderate, severe/extremely severe), and clinician-report (none, mild, moderate, severe). Age- and gender-matched norms were compared with all defined severity groups. RESULTS: Compared with the norms, control subjects scored higher on all SF-36 scales. Effect size (ES) ranged from 0.15 to 0.52. Non-SS KCS patients had lower Role-Physical (ES=-0.07), Bodily Pain (ES=-0.08), and Vitality (ES=-0.11) scores, indicating more dry eye impact on those areas versus the norm. All SF-36 scale scores except Mental Health (ES=0.12) were lower in the SS group than the adjusted norm (ES range: -0.16 to -0.99). Regardless of severity classification, mild patients consistently had lower Role-Physical and Bodily Pain scores than the norm, suggesting impact on daily roles (ES < 0.2). Patients with moderately severe disease also experienced less vitality and poorer general health. The group with severe disease scored lower than the norm across all domains (ES range: -0.14 to -0.91) except Role-Emotional (ES=0.13) and Mental Health (ES=0.23). CONCLUSIONS: These results indicate dry eye's negative impact on everyday life, particularly in daily activities. Further research using disease-specific measures to examine dry eye's impact is underway.

PURPOSE: To investigate symptom profiles and clinical signs in subjects with dry eye of varying severity. METHODS: Subjects aged 35 to 65 were recruited according to dry eye diagnostic codes and telephone interview and completed the Dry Eye Questionnaire 2001, among others, and underwent dry eye clinical tests. RESULTS: Subjects (122) included 28 control subjects (C), 73 with non-Sjögren's keratoconjunctivitis sicca (non-SS KCS) and 21 with Sjögren's syndrome (SS). Subjects with SS or non-SS KCS reported discomfort and dryness most frequently and that many symptoms worsened over the day and were quite bothersome. Groups were significantly different in corneal fluorescein staining, conjunctival lissamine green staining, Schirmer 1 tear test, and tear break-up time (TBUT; chi2 and Kruskal-Wallis, P<0.0001). Statistically significant, but moderate, correlations were found between the frequency and evening intensity of dryness and discomfort and TBUT, Schirmer's tear
test, overall corneal fluorescein staining, and temporal lissamine green conjunctival staining (Spearman r=0.31-0.45, P<0.01). Symptoms were moderately to highly correlated with the clinician's global grading of severity and highly correlated to patient's self-assessment of severity (r=0.46-0.86, P<0.0001), whereas signs showed lower correlations (r=0.22-0.46, P<0.0001).

CONCLUSIONS: Subjects with SS or non-SS KCS reported frequent and intense ocular surface symptoms in the evening, some of which correlated moderately with clinical test results. The global clinician grade of dry eye correlated more highly with patient symptoms than did clinical signs, suggesting that patient symptoms influence dry eye diagnosis and grading of dry eye more than clinical test results.


PURPOSE: To generate a profile of genes expressed in the retina, RPE, and choroid after laser treatment and to identify genes that may contribute to the beneficial effects of laser photocoagulation in the treatment of angiogenic retinal diseases.

METHODS: Argon laser irradiation was delivered to the left eye of normal C57BL/6J mice (n = 30), with the right eye serving as the control in each animal. Three days after laser treatment, mice were culled, eyes enucleated, and the retinas dissected and pooled into respective groups. The total RNA of replicate samples was extracted, and expression profiles were obtained by microarray analysis. Data comparisons between control and treated samples were performed and statistically analyzed.

RESULTS: Data revealed that the expression of 265 known genes and expressed sequence tags (ESTs) changed after laser treatment. Of those, 25 were found to be upregulated. These genes represented a number of biological processes, including photoreceptor metabolism, synaptic function, structural proteins, and adhesion molecules. Thus angiotensin II type 2 receptor (Agtr2), a potential candidate in the inhibition of VEGF-induced angiogenesis, was upregulated, whereas potential modulators of endothelial cell function, permeability factors, and VEGF inducers, such as FGF-14, FGF-16, IL-1beta, calcitonin receptor-like receptor (CRLR), and plasminogen activator inhibitor-2 (PAI2), were downregulated.

CONCLUSIONS: In this study, genes were identified that both explain and contribute to the beneficial effects of laser photocoagulation in the treatment of angiogenic retinal diseases. The molecular insights into the therapeutic effects of laser photocoagulation may provide a basis for future therapeutic strategies.


PURPOSE: The aim of the current study was to develop quantitative methods to assess optical aberrations caused by tear film disruption.

METHODS: We used standard fluorescein imaging (FL) and a novel retroillumination (RI) method to image tear film disruption in 12 eyes. Using a clinical slit lamp biomicroscope, we alternated between widefield blue and narrow-beam white light to obtain an interleaved series of FL and RI images of the time course and pattern of tear film break-up. We developed an optical analysis that indicates that the RI image should be proportional to the spatial derivative of the FL image. Intensity fluctuations in the RI images are due to thickness changes in the tear film, whereas intensity fluctuations in FL images are directly determined by tear film thickness.

RESULTS: As predicted by optical analysis of RI, the spatial distribution of gaps in the tear film seen with fluorescein appeared as pairs of light and dark contours in the RI images, and a precise correspondence between the spatial derivative of the FL image (slope) and the RI image was found. Both methods showed a gradual spreading of the tear disruption during blink suppression that varied tremendously among eyes in both time and spatial pattern. Resumption of normal blinking did not produce an immediate reconstitution of the normal tear film, and areas of tear break-up created during blink suppression remained abnormal for up to several minutes of normal blinking.

CONCLUSIONS: Our analysis indicates that both FL and RI have the potential to quantify optical changes occurring during tear break-up. These results support an interpretation of RI as an intensity-based method for mapping the highly irregular optical aberrations of the eye produced by tear film disruption.

27. Begley CG, Caffery B, Chalmers RL, Mitchell GL; Dry Eye Investigation (DREI) Study Group. Use of the dry eye questionnaire to measure

PURPOSE: To demonstrate the ability of the Dry Eye Questionnaire (DEQ) to characterize the frequency of ocular surface symptoms and their diurnal intensity in patients with Sjögren's syndrome (SS), keratoconjunctivitis sicca (KCS), and age-matched controls.

METHODS: One hundred patients with tear-deficient dry eye from Toronto Western Hospital were mailed the DEQ and the McMonnies' questionnaire (MQ). Age- and gender-matched controls were selected from an historical data set. The DEQ measured the habitual frequency, intensity, and impact of common ocular surface symptoms and asked questions about computer use, medications, and allergies.

RESULTS: Sixty-two dry eye subjects responded; 30 with SS and 32 with KCS. Compared with controls, SS subjects consistently reported the highest frequency and intensity of symptoms, followed by non-KCS subjects. The intensity of symptoms was significantly greater in the evening than in the morning among SS subjects for all symptoms except dryness and light sensitivity (p < 0.05). Sixty percent of SS subjects reported the need to stop daily activities and close their eyes due to dryness, burning, and light sensitivity.

CONCLUSIONS: Symptoms of ocular irritation were frequent and intense among SS and KCS subjects. These symptoms often increased in intensity over the day, suggesting that open-eye conditions affect the progression of symptoms. Measurement of symptom frequency and diurnal intensity by the DEQ provides a sensitive tool that may be useful in clinical treatment trials for dry eye.

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PURPOSE: The contact lens dry eye questionnaire (CLDEQ) is a self-administered survey developed to examine the distribution of dry eye symptoms among contact lens wearers. In this report, we examine the CLDEQ as a screening survey for contact lens-related dry eye and compare it with McMonnies' questionnaire.

METHODS: The CLDEQ and McMonnies' questionnaire were administered to 367 unselected contact lens wearers at six clinics across the United States and Canada. After completion of the surveys, doctors unaware of the survey results completed a separate form indicating contact lens-related dry eye diagnosis at the end of a nondirected clinical examination. The CLDEQ is composed of nine habitual symptom subscales and a self-diagnosis question, which were tested for their predictive value for a diagnosis of contact lens-related dry eye. McMonnies' instrument was scored with use of the algorithm suggested in the literature. Sensitivity, specificity, and receiver operator characteristic (ROC) curve analyses were performed for each instrument on the basis of logistic regression results.

RESULTS: The area under the ROC curve for the CLDEQ was 0.74, indicating moderate contact lens-related dry eye discrimination, and the Hosmer-Lemeshow goodness-of-fit test indicated that the CLDEQ was well calibrated (p = 0.84).
under the ROC curve for McMonnies' questionnaire was 0.56, indicating poorer discrimination, and the Hosmer-Lemeshow goodness-of-fit test indicated it was also poorly calibrated (p = 0.08) for contact lens wearers.

CONCLUSIONS: These analyses suggest that the CLDEQ is capable of discriminating contact lens-related dry eye and is accurate in doing so, especially in comparison with McMonnies' questionnaire. The CLDEQ is an efficient screening survey and may be used in future clinical research and epidemiologic studies of contact lens-related dry eye.


PURPOSE: This study sought to assess the feasibility of impression cytology for the determination of conjunctival intracellular lysosomal hydrolase (acid esterase) levels in patients with keratoconus.

METHODS: Twenty-two patients with keratoconus currently enrolled in the Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study and 22 age-and sex-similar controls underwent impression cytology. Samples were collected from each subject and control pair on the same day. The cells of the respective specimens were fixed immediately and were stained for acid esterase with use of identical batches of fixatives and stains. After staining, the specimens were cleared in xylene for mounting in synthetic resin on glass slides. The acid esterase staining intensity of each specimen was quantified as the percentage of light transmitted with use of an image analysis system (Zeiss). Multiple cells from each specimen were analyzed for each sample collected.

RESULTS: Mixed model analysis was used to account for the subject-control pairings and for the multiple cells from each sample. With this method, the mean light transmission for normal controls (mean = 63.0; standard error [SE] = 3.0) was highly statistically significantly different from that for the keratoconus subjects (mean = 52.4; SE = 3.0) (two-tailed p = 0.0032).

CONCLUSIONS: This study establishes the feasibility of adapting an acid esterase staining technique to conjunctival cells collected via impression cytology. Higher levels of lysosomal enzyme staining in patients with keratoconus have been previously reported by other investigators using full-thickness conjunctival specimens. We also demonstrate the value of using objective microspectrophotometry in measuring lysosomal enzyme staining with impression cytology specimens.


PURPOSE: This study characterized ocular symptoms typical of dry eye in an unselected optometric clinical population in the United States and Canada.
METHODS: Self-administered dry eye questionnaires, one for non-contact lens wearers (dry eye questionnaire) and one for contact lens wearers (contact lens dry eye questionnaire), were completed at six clinical sites in North America. Both questionnaires included categoric scales to measure the prevalence, frequency, diurnal severity, and intrusiveness of nine ocular surface symptoms. The questionnaires also asked how much these ocular symptoms affected daily activities and contained questions about computer use, medications, and allergies. The examining doctors, who were masked to questionnaire responses, recorded a nondirected dry eye diagnosis for each patient, based on their own diagnostic criteria.

RESULTS: The dry eye questionnaires were completed by 1,054 patients. The most common ocular symptom was discomfort, with 64% of non-contact lens wearers and 79% of contact lens wearers reporting the symptom at least infrequently. There was a diurnal increase in the intensity of many symptoms, with symptoms such as discomfort, dryness, and visual changes reported to be more intense in the evening. The 22% percent of non-contact lens wearers and 15% of contact lens wearers diagnosed with dry eye (most in the mild to moderate categories) reported symptoms at a greater frequency than those not diagnosed with dry eye.

CONCLUSIONS: Our results show that symptoms of ocular irritation and visual disturbances were relatively common in this unselected clinical population. The intensity of many ocular symptoms increased late in the day, which suggested that environmental factors played a role in the etiology of the symptoms.


PURPOSE: In this investigation, we characterized cells collected from the normal human ocular surface using contact lens cytology (CLC).

METHODS: Cells were characterized over the course of a day in three different ways. In experiment 1, we collected samples from 10 subjects six times during 1 day. Cell viability was determined by a calcein-ethidium assay. The same collection methods were used in experiment 2, but cell types were identified by fluorescent probes AE5 (corneal epithelium), AE1, AE3 (all epithelium), and T200 (all inflammatory cells). In experiment 3, cells were collected from five subjects two times in 1 day and characterized by fluorescent probes CD3 (T cells) and CD19 (B cells). For morning samples, we used an HLA-DR probe and transmission electron microscopy to examine the inflammatory activation of collected cells.

RESULTS: We found viable and nonviable cells in all CLC samples, as well as an intermediate cell type that stained with both calcein and ethidium. There was a diurnal variation in cell numbers over the course of 1 day in viability and cell type assays, with greater cell numbers collected in the morning and evening, and fewest at midday. In the late afternoon and evening, there was an increase in corneal epithelial cell counts. There were more inflammatory cells in morning collections that included polymorphonuclear cells (PMNs). Many of these were HLA-DR+ and actively phagocytic, reflecting the immune activation of cells.
CONCLUSION: The ocular surface is a dynamic environment characterized by cyclical shedding of the epithelium and active monitoring by immune cells.

The purpose of this study was to examine ocular symptoms that have been associated with dry eye among contact lens wearers. A dry eye questionnaire was administered at random to 83 contact lens wearers at a private practice in Toronto, Ontario. On average, the most frequent ocular symptom among those queried was dryness and the least frequent was soreness. There was a significant shift (p < 0.0001; paired t-test) toward increased symptoms in the evening compared with the morning. Blurry, changeable vision was also a frequent and noticeable symptom. However, most subjects reported that their ocular symptoms were not severe enough for them to stop work or hobbies or to remove their contact lenses. Our results show that the symptoms of ocular dryness and discomfort are relatively common among contact lens wearers, and that they worsen toward the end of the day. These findings suggest that lens care practitioners should examine their patients who wear contact lenses toward the end of the day to best identify symptomatic patients.

PURPOSE: The purpose of this study was to develop a pilot survey to evaluate ocular irritation symptom frequency, severity, and impact on daily activity in patients previously diagnosed with dry eye.
METHODS: Forty-five patients previously diagnosed with dry eye (ICD-9 code 375.15) completed the 17-item symptom survey. Analog-scale response questions concerning the frequency, severity, and effect on daily activity were asked for the following symptoms: dryness, scratchiness and soreness, burning and stinging, light sensitivity, blurry vision, and ocular itching.
RESULTS: Dryness and soreness were the most frequently reported symptoms of ocular irritation. Although the occurrence of symptoms of ocular irritation was reported as frequent by patients diagnosed with dry eye, the symptoms had minimal to moderate impact on daily activity.
CONCLUSIONS: Patient expression of the symptoms of dryness and soreness at more frequent and/or more severe levels may lend more validity to a diagnosis of dry eye.

PURPOSE: The purpose of the test-retest phase of the Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study was to determine the repeatability of the
various parts of the CLEK Study protocol. This paper presents the test-retest parameters of the refraction protocol.

METHODS: We examined 138 CLEK Study-eligible patients on two occasions (median, 90 days; range, 22 to 268 days). All patients underwent subjective refraction on two occasions, and contact lens over-refractions were performed either over the patient’s habitual rigid contact lenses or over a trial rigid contact lens equal in base curve to the steep keratometric reading in nonrigid contact lens wearers.

RESULTS: Mean interoccasion differences +/- SD were -0.32 +/- 2.91 D and -0.17 +/- 1.39 D for subjective refraction sphere and cylinder power, respectively, and the mean absolute difference for subjective refraction cylinder axis was 18.1 +/- 20.2 degrees. The mean interoccasion difference +/- SD for high-contrast visual acuity with subjective refraction was 0.38 +/- 10.9 letters correct. Mean interoccasion differences +/- SD were -0.11 +/- 0.81 D and 0.02 +/- 0.67 D for contact lens over-refraction sphere and cylinder power, respectively, and the mean absolute difference for contact lens over-refraction cylinder axis was 11.6 +/- 9.9 degrees. The mean interoccasion difference +/- SD for visual acuity with contact lens over-refraction was 0.50 +/- 5.2 letters correct and 0.71 +/- 6.9 letters correct for high- and low-contrast visual acuity, respectively.

CONCLUSIONS: The repeatability of subjective refraction in keratoconus patients is good but somewhat lower than that found in nondiseased eyes. Only 36% of our repeat measures of sphere power from subjective refraction fell within 0.50 D of each other, compared with more than 90% in studies of normal eyes.


PURPOSE: This study was conducted to determine the agreement and test-retest repeatability of two methods for measuring corneal curvature in keratoconus: keratometry and the First Definite Apical Clearance Lens (FDACL). Our interest in the FDACL procedure stems from the important contact lens-fitting information and documentation of disease progression provided by the FDACL trial lenses and observation of fluorescein patterns.

METHODS: The Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study is an observational study that has enrolled 1,209 keratoconus patients to characterize the progression of keratoconus, to determine factors associated with its progression, and to assess its impact on quality of life. Ten percent of the patients were randomly selected at baseline for a retest examination. The baseline examination, which included keratometry and FDACL, was repeated in this sample. The FDACL is the flattest lens in the standardized CLEK trial lens set that vaults the apex of the cone. FDACL provides an estimate of the sagittal height of the cone.
RESULTS: The correlation of FDACL with the steep keratometric reading \( r = 0.89; p = 0.0001 \) and the flat keratometric reading \( r = 0.83; p = 0.0001 \) were high. Test-retest repeatability as measured by the intraclass correlation coefficient (ICC) was high: FDACL ICC, 0.97; steep keratometric reading ICC, 0.96; and flat keratometric reading ICC, 0.95. Test-retest repeatability of FDACL remained high in advanced disease. CONCLUSION: FDACL provides a repeatable new procedure for determining disease severity in keratoconus.


Corneal fluorescein staining is widely used in clinical practice and research, but little information exists on the distribution of staining in a large group of asymptomatic contact lens wearers. This cross-sectional study took place at 3 centers, and investigated the pattern of corneal fluorescein staining in both eyes of 98 hydrogel contact lens wearers. We also investigated the strategies used by three experienced clinicians to grade corneal staining. Overall corneal staining was graded using a scale from 0 to 4 in one-half steps, and five corneal zones, superior, inferior, nasal, temporal, and central, were also graded. The average overall staining grade for both eyes of our subjects was 0.50, with an average of 0.57 for the right eye and 0.44 for the left. This difference between the eyes was statistically significant \( (p = 0.011) \). In addition, a comparison of the zones within each eye showed a significant difference \( (p = 0.0001) \) among the zones. Corneal staining between the two eyes was also positively and significantly correlated \( r = 0.58; p = 0.0001 \). Grading strategies among clinical investigators were significantly different \( (p = 0.0001) \), indicating a potential source of bias in multi-centered studies. The difference in corneal staining between the eyes may represent a source of systematic bias, and could be due to grading the right eye before the left. The correlation in corneal staining between the eyes indicates that the two eyes of a subject cannot serve as independent data points. One-third of the subjects who participated in this study had notable corneal staining. This finding underlines the importance of regularly checking corneal staining in clinical practice.


BACKGROUND: This investigation compared the efficacy of three widely used contact lens disinfection systems against an ocular isolate of Acanthamoeba polyphaga. METHODS: Twenty-seven worn Ciba NewVues lenses were quartered, heat sterilized and inoculated with Acanthamoeba. Lens quarters were then randomly assigned to three experimental groups, with Group A lenses exposed to cleaner and saline rinse only, Group B to disinfection only, and Group C to both cleaner and disinfection. One quarter of each lens served as a control and the other three quarters were experimental. Quantification of viable Acanthamoeba remaining on the lens was performed after each step of the disinfection process.
RESULTS: Group A lenses showed no significant difference between the treatments, or the treatments and the control. Group B lenses demonstrated a significant difference (p = 0.0001) between the treatments and the control. In Group C (cleaning and disinfection), the control lens quarters were significantly different (p = 0.037) from the experimental group, but there was no significant difference between the treatments.

CONCLUSIONS: All three disinfection regimens were very effective in reducing the number of viable Acanthamoeba on the contact lens surface. In the absence of proper cleaning (Group B), AOSept was the most effective of the three. These results also show the importance of thoroughly rubbing the contact lens surface to decrease the number of Acanthamoeba.


A method to study the synthesis and cellular processing of epithelial apical membrane glycoproteins in the rabbit cornea was developed. Fluorescent derivatives of wheat germ agglutinin (WGA; alpha-N-acetylglucosamine and sialic acid hapten affinities), succinylated WGA (alpha-N-acetylglucosamine hapten affinity) and concavalin A (Con A; D-mannose and D-glucose hapten affinity) were reacted with the corneal surface and the extent of binding attained was measured by en face, microscope-aided fluorophotometry. Minimal binding of succinylated WGA and a large reduction in WGA binding following neuraminidase treatment demonstrated that the attachment of WGA to the corneal surface occurred via sialic acid residues, i.e. via structures associated with terminal glycosylation. Corneas were treated with digitonin to induce the exfoliation of the outer squamous-like cell layers. The time-dependent changes in lectin binding density at the apical surface of the newly exposed intrastral cells were then determined. Binding densities for WGA and Con A at the time of exfoliation of the digitonin-devitalized squamous cell layers (< 2 hr post-devitalization) were similar to the densities measured at the surface of untreated corneas. Over the subsequent 18-20 hr, the WGA and Con A binding increased by 2.63 +/- 0.24 and 3.0 +/- 0.68 (+/- S.D., n = 4) fold, respectively. The effect of inhibitors of transcription (actinomycin D, alpha-amanitin), translation (cycloheximide), core glycosylation of polypeptides (tunicamycin), endoplasmic reticulum glucosidases (deoxinojirimycin) and Golgi mannosidase (swainsonine) indicated that the increases were underpinned by new glycoprotein synthesis driven by a stable, pre-existing mRNA pool. Retinoic acid (2 microM) inhibited the increase in WGA binding by 55 +/- 6% (n = 4) but did not affect the Con A density increase suggesting that this agent either, modifies the terminal glycosylation pattern of apical membrane proteins and/or inhibits the synthesis of proteins bearing sialic acid. Actinomycin D or alpha-amanitin reverted the retinoic acid action, indicating that the retinoid effect is mediated by induced gene expression.


This investigation compared the effects of three commercial soft contact lens solutions on the rabbit corneal epithelium. Fifteen rabbits wore lenses soaked in ReNu multi-
purpose disinfecting solution, Opti-Free rinsing, disinfecting and storage solution, and neutralized AOSEPT for a period of 30 minutes. Control eyes wore lenses soaked in unpreserved saline for the same time period. Corneas were photographed by scanning electron microscopy and graded in random locations across the corneal surface. Slides of these photographs were projected at a magnification of x3000 and graded according to two scales by an observer unaware of the treatment used. The results showed a significant treatment effect, with all three experimental solutions scoring higher than controls. When the three experimental solutions were compared, corneas exposed to ReNu multi-purpose disinfecting solution showed a significantly increased effect by contingency table analysis of data from the adapted Burstein’s scale.


The efficacies of five FDA-approved soft contact lens disinfecting solutions and heat disinfection were evaluated against the mold, Beauveria bassiana. Beauveria bassiana is a ubiquitous soil fungus with a demonstrated ability to grow into a soft contact lens matrix. A stock solution of the fungus was prepared and aliquots were added to each of the following disinfection solutions: ReNu Multi-Purpose Disinfecting Solution, Opti-Free, AOSEPT Disinfection/Neutralization Solution, Lens Plus Oxysept 1, UltraCare, and a Softmate Thermal Disinfecting Unit. Hydrogen peroxide systems were neutralized immediately using the manufacturer’s recommended method. After 1 min, 5 mins, 15 mins, 30 mins, 1 hour, 4 hours, and 8 hours; samples were removed, added to neutralizing broth, and streaked onto Sabouraud’s Dextrose Agar plates. Our results showed that hydrogen peroxide and heat disinfection were much more effective against Beauveria bassiana than Opti-Free or ReNu.


In this investigation, the effects of three rigid gas permeable (RGP) contact lens wetting and soaking solutions, Boston Advance Conditioning Solution, Boston Conditioning Solution, and Allergan Wet-N-Soak Plus, were tested on the human corneal epithelium. Thirty subjects participated in three experimental sessions, during which one eye received three drops of one of these RGP solutions, while the other eye served as a control. After 10 and 30 min, corneal staining was graded in 5 areas and the eyes were photographed for a digitized analysis of staining. Our results indicate that corneas exposed to Boston Advance Conditioning Solution demonstrated significantly more fluorescein staining than control eyes at both 10 and 30 min by both methods of analysis, whereas corneas treated with the other two solutions were not significantly different from controls. The increased corneal staining noted with Boston Advance Conditioning Solution may be caused by the presence and concentration of the preservative, 0.0015% polyaminopropyl biguanide. An unforeseen result of this experiment was the relatively large number of subjects exposed to Boston Conditioning...
Solution and Allergan Wet-N-Soak Plus who had more corneal staining in the control eye. This may suggest that the two RGP solutions served as a barrier to fluorescein, protecting the epithelial cells from staining.


This investigation was designed to compare the effects of three rigid gas permeable (RGP) contact lens solutions on the rabbit corneal epithelium. Boston Advance Conditioning Solution, Boston Conditioning Solution, and Allergan Wet-N-Soak, which are preserved with 0.0015% polyaminopropyl biguanide, 0.006% chlorhexidine gluconate, and 0.003% benzalkonium chloride, respectively, were evaluated by scanning (SEM) and transmission electron microscopy (TEM). Our results show that Boston Advance Conditioning Solution is significantly more toxic to the corneal epithelium than either Boston Conditioning Solution or Allergan Wet-N-Soak Plus. This is presumably due to the presence and concentration of the preservative, 0.0015% polyaminopropyl biguanide. Although this study was conducted using rabbits, the results raise clinical concerns for human RGP contact lens wearers.


Approximately 6.8 percent of soft contact lens wearers develop multiple nodular deposits on the front surface of their soft contact lenses. It was the purpose of this investigation to evaluate the role of calcium in the newly formed and mature deposits. Nodular deposits were examined using scanning electron microscopy and Energy Dispersive X-ray (EDX) analysis for calcium content. Any deposit which did not demonstrate the presence of calcium was sectioned, and the individual section re-examined by EDX analysis. Our results indicate that calcium was present in all but three of 72 nodular deposits investigated. The calcium was finely distributed throughout the deposits in a non-crystalline pattern, especially in the basal layers. Sections of the deposits also were examined at the light microscope level for the presence of lipids, calcium, and polysaccharides (mucin). All deposits stained positively for lipids, but polysaccharides were more evident in newer deposits. These results may indicate that both calcium and polysaccharides are involved in the genesis of nodular deposits.


Giant papillary conjunctivitis (GPC) is largely a soft contact lens-related syndrome, characterized by the formation of giant papillae on the upper tarsal conjunctiva, itching, excess mucus, erythema, and contact lens intolerance. In response to the suggestion that GPC occurs more frequently in atopic individuals, a retrospective study was designed in order to determine the months in which patients were diagnosed with GPC during 1987 and 1988. Personal histories of allergy were also recorded for these
patients, and compared to an age- and sex-matched control group. Significant peaks in the number of patients diagnosed with GPC occurred in the spring, and especially in late summer/early fall of both years. In addition, the GPC patients reported significantly more overall allergies than did the control group. However, a breakdown of the individual allergy data revealed that only allergies to contact lens solutions, specifically thimerosal, were significantly higher in the GPC group. Reported allergies to medications and pollen were also elevated in the GPC patients, but not significantly. The seasonal onset of GPC diagnoses in 1987 and 1988, and the increase in reported allergies within the GPC group, suggests a strong association between atopy and the development of GPC.


Currently, in the United States, the Food and Drug Administration has approved a number of enzyme cleaners for use with soft contact lenses. These cleaners contain three active enzymes--papain, pancreatin, and subtilisin. Although several studies have compared the cleaning efficacy of papain and pancreatin, little information exists concerning subtilisin. It was the aim of this investigation to compare the performances of four marketed enzyme cleaners, including Allergan Enzymatic (papain), Optizyme (pancreatin), ReNu Effervescent (subtilisin), and Ultrazyme (subtilisin A). Lenses were examined using the scanning electron microscope, and the amount of deposits on the lens surfaces quantified by digital analysis. All of the enzyme cleaners were effective in removing deposits from the contact lenses surfaces, but there was no significant difference in the cleaning efficacy of the four cleaners tested.