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A NEW OBJECTIVE SYSTEM FOR GRADING CORNEAL HAZE (O.A. Land1, R.W. Bornstein1, C.A. Hallock2, S.C. Kaufman3, S.J. Chey1) Department of Ophthalmology, Loma Linda University Medical Center, Remote Sampling & Image Processing Lab, Loma Linda University State University2, Rochester University3.

Purpose: The purpose of this study was to develop a grading scale based on digital image properties to objectively quantify the corneal haze that accompanies swelling and stromal opacification in these eyes. The scale is more precise and reliable than the familiar 4-grade system.

Methods: In vivo confocal microscopy of the corneas were obtained from rabbits before and immediately after excimer laser refractive surgery and then daily for six days. Images show trends in the frequency of keratocytes and characteristics of a number of detectable morphologic features. This system approaches the problem by quantifying detectable features such as the density, size, and reflectivity of keratocytes and stromal opacification. A computer-aided image analysis system was interfaced to the confocal microscope for quantification of pericorneal keratocytes. Results: Quantification of morphologic features that are concomitant to increased haze results in a set of indices for each image that indicate its position along the normal line observed in experimental data, thus allowing the degree of haze of the image. In images, the nuclear size is shown as a linear trend for each excimer laser procedure, and can be used to determine the degree of haze.

Conclusions: The objective grading of haze by computer-based algorithms can effectively replace the medical 4-grade subjective clinical grading system currently in use for characterizing corneal haze. Such a system would be useful in assessing the degree of wound healing following laser surgery.

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COLOR CODIFICATION OF CORNEAL HAZE OVER THE ENTRANCE PUPIL AFTER LASER FLOWER SURGERY FOR MYOPIA (S.G. Ahmad1, J.I. Bulas2, M.J. Maldonado3, F.M. Estrada4, A. Nazary5, R. Martinez-Costa3, A. Ruiz6, and J.L. Mones3) Department of Electrical Engineering and Computer Science2, University of Illinois at Urbana-Champaign2, Department of Ophthalmology, La Fe University Hospital and Department of Surgery, University of Valencia, Spain.

Purpose: Regional variations in corneal haze can occur within the ablation zone in an eye after photorefractive keratectomy. We attempted to develop color-coded maps for presenting information on the distribution of haze over the entrance pupil after excimer laser surgery. Methods: Digitalized anterior slit-lamp photographs of all eyes that had undergone excimer laser surgery for myopia were analyzed using computerized grayscale edge detectors. Differences in grayscale level between the treated area and the untreated area on the anterior corneal surface were analyzed and compared to differences in grayscale levels between different eyes. Results: We obtained successful color codification of the corneal opacities over the entrance pupill in all the eyes examined. We were able to distinguish between areas containing haze and areas only containing original color maps. The pattern distribution of corneal haze was also highlighted and easily identified.

Conclusions: This method appears to be effective for visually recognizing the pattern and distribution of corneal haze caused by the pupillary aperture after excimer laser photorefractive keratectomy.

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REPRODUCIBILITY OF DIRECT OBJECTIVE QUANTIFICATION OF CORNEAL HAZE BY DIGITAL IMAGE ANALYSIS FOLLOWING MYOPIC PHOTOREFRACTIVE KERATECTOMY (S.G. Ahmad1, M.J. Maldonado2, J.J. Beld1, A. Nazary5, R. Martinez-Costa3, F.M. Estrada4, A. Ruiz6, and J.L. Mones3) Department of Electrical Engineering and Computer Science2, University of Illinois at Urbana-Champaign2, Department of Ophthalmology, La Fe University Hospital and Department of Surgery, University of Valencia, Spain.

Purpose: To evaluate the reliability of image analysis for quantifying corneal haze by determining the reproducibility of its measurements at the corneal plane. Methods: The corneas of post-photorfractive keratectomy patients were photographed before and after surgery on their anterior surface. Each photograph was then examined using computer image analysis techniques that detect the edge of the corneal epithelium from the corneal plane. Quantification of the difference between two areas, treated and adjacent untreated cornea, each containing 3750 points with a resolution of 336 grayscale levels was performed. The reproducibility of the procedure was determined by evaluating the photographs of twenty random eyes obtained by two observers under identical conditions on four separate visits. The inter-observer variation was calculated using the first measurement and the mean of the four measurements. Results: The pooled standard deviation of the measurements for observer one and two was 0.25 grays levels and 0.42 gray levels, respectively. The mean inter-observer variation was 0.24 ± 0.17 gray levels for the first measurement and 0.25 ± 0.17 gray levels for the mean of the four measurements. Conclusions: Good reproducibility for haze measurement by digital image analysis of the differences between the treated and adjacent untreated corneal area was obtained. The average of four measurements was calculated to improve their reproducibility. This new technique could potentially be used in quality assurance and analysis haze after excimer laser photorefractive keratectomy.

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A SENSITIVE CORNEAL HAZEMETER (I.M. Maurice) Department of Ophthalmology, Columbia University Medical Center, New York, N.Y.

Purpose: To design and evaluate an instrument to measure low degrees of corneal opacity.

Methods: Two overlapping vertical slits of light are focused on the cornea from 45° nasally and 45° temporally. This makes the corneal light from an opacity relatively insensitive to it being a small angle of the optical axis. The slits are formed by spherical apertures so that straight lines, 2.5 mm, are projected on the eye. The beam from a halogen lamp, divided symmetrically, provides the illumination. A CCD camera, mounted centrally, records the corneal image for linear scanning. The pupil is dilated before observations. The effect of epidermal irregularities can be eliminated by covering the corneal surface with a deep fluid chamber formed by a contact lens separated from the eye by a 2 mm thick ring, and attached by light suction. Results: With symmetrical illumination, images may be obtained without difficulty from any region of the human cornea above the striae diurnales and around the horizontal meridian in the rabbit. Because the projected slit passes through the eye at a right angle, for the investigation of the area around a central or striae diurnales, the light is not visible in the slit lamp.

Conclusions: It is possible to make an objective measurement of haze resulting from PRK or other corneal disorders or interventions using a simple set up. This could be useful in corroborating if the CCD camera was replaced by its chip and a simple lens, and the circuitry was distributed throughout the space unused by the optics.

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EVALUATION OF PENTOXIFYLLINE IN THE PREVENTION OF HAZE AFTER PHOTOREFRACTIVE KERATECTOMY IN THE RABBIT (E.C. Abad1, J.E. Lim2, A. Pepel1 and J.H. Talan12) Cornea Service, MEER/Herbert Medical School, Boston, MA.

Purpose: Pentoxyfylline (PTX) is a methylxanthine derivative that has numerous hemorheologic properties allowing it to form multifactorial effects at the cellular level. It has been used in kieldahl prevention due to its ability to inhibit the secretion of collagenase by human gingival fibroblasts stimulated by transforming growth factor beta and in the rabbit model to prevent haze following photorefractive keratectomy. Methods: 16 NZW rabbits underwent -0.50 diopters of PRK after laser ablation of the epithelium with a VEX 9300 excimer laser. The base ablation was started with a 5.0 mm, 0.35 micron, 200 mJ, 80 Hz, 90% of unoccluded (DTAP). The procedure was done in both eyes one week apart. A 0.5% eye received 1% PTX qid and the other BSS qid as a control for four weeks, starting the second day of surgery. The amount of haze was graded by a masked observer using the slit lamp at 2:6.4 and 9:4 weeks. Four rabbits were sacrificed at each time point for histopathologic analysis. The area from the DTAP-stained collagen was taken out of the base of the epithelium was measured using a digital image analysis (BIS). Results: There was no statistical significant difference in the amount of haze among the PTX treated eyes and the controls at any time interval (Student's T test: 0.16-0.99). Conclusions: Despite promising results in kieldahl prevention, pentoxyfylline did not affect the degree of haze formation in a PRK rabbit model. Further research is needed to confirm these preliminary findings. Supported by New England Eye Bank grant 50036.

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COMPARISON OF POSTOPERATIVE CORNEAL SENSATION FOLLOWING PHOTOREFRACTIVE KERATECTOMY AND LASIK IN-SITU KERATOMILEUSIS (E.N. Delangris1, A.J. Kranidopoulos2, A.D. Paliakis3, M.E. Dincorani2, K.L. Krikelis2, A.M. Lambropoulos4, and H.D. Perrin5) (1) Tufts Medical School, (2) Harvard Medical School, Massachusetts Eye and Ear Infirmary, Boston, MA, (3) New York University Medical College, North Shore University Hospital, Manhasset, NY, (4) University of Crete Medical School, Heraklion, Greece, (5) Grails Eye Center, Athens, Greece.

Purpose: To evaluate the effect on corneal sensation of photorefractive keratectomy (PRK) versus laser in-situ keratomileusis (LASIK). Methods: In a masked study, corneal sensation was measured with the Cockburn-torren anesthesiometer in 49 consecutive patients, 6 to 12 months following PRK and LASIK. (600 consolates natural reading and 600 items spontaneously). The mean corneal sensation following PRK was 3.02cs (range 3-5) after 6 to 12 months (mean 9.3 months). The mean corneal sensation following LASIK was 5.28cs (range 4-6), after 6 to 12 months (mean 9.3 months). The mean correction accepted for PRK was 3.75 diopters (3.5-12 diopters) and for LASIK 11.75 diopters (5-15 diopters). Conclusions: In this group of patients, with correction of primarily, near myopic, corneal sensation was significantly greater (P < 0.001) following LASIK compared to PRK.

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