321 Ocular Scattering, Transmittance and Reflectance
Tuesday, May 8, 2012, 8:30 AM - 10:15 AM
Hall B/C Poster Session
Program #/Board # Range: 3052-3073/D1074-D1095
Organizing Section: Visual Psychophysics/Physiological Optics
Contributing Section(s): Lens,Cornea

Program Number: 3052 **Poster Board Number:** D1074
Presentation Time: 8:30 AM - 10:15 AM
Intraocular Scattering in Double-Pass Retinal Reflex
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Purpose: The accuracy, precision and breadth of ocular testing using double-pass photorefraction are affected by intraocular scattering. The purpose of this study is to evaluate and quantify the intraocular scatter in infrared double-pass photorefraction.
Methods: An infrared multi-eccentricity-meridian photoscreening method was used to acquire retinal reflex images in 45 optometry students and volunteers (13 males and 32 females) between 22 and 43 years of age. In this cohort, there were 8 African Americans, 3 Indians and 34 whites. Standard eye examinations were performed for all test subjects (90 eyes; Spherical equivalent ranged from +1 to -8.75 diopters). All eyes were healthy with no significant intraocular abnormities except for one subject (2 eyes) with congenital nuclear cataracts. The ocular scattering is determined from the pedestal-like signal in the retinal reflex image. A scattering factor was defined as the ratio of the scattering signal and the refraction signal. Correlations with age, race, and refractive error were analyzed.
Results: As expected, the scatter factor was closely related to the spherical equivalent (SE). The amplitude of the scattering factor is larger for smaller SE and smaller for eyes with high refractive errors. Surprisingly, there was no significant relationship between the scatter factor and age or race in our sample. The scattering factors of the 2 eyes with nuclear cataracts were at the high end of the distribution curve.
Conclusions: The scatter factor in photorefraction shows potential for quantifying ocular scattering in individuals with a wide range of refractive errors. The scatter factor exhibited no significant dependence on the race of the subject. Also, no age sensitivity was detected, but this result is expected for the restricted age range of our observed cohort. Further studies on a larger sample size, wider age range, and inclusion of cataract patients are necessary to draw more general conclusions.
Commercial Relationships: **Lei Shi**, None; **E. E. Hartmann**, None; **Naser T. Naser**, None; **J W L. Lewis**, None; **Ying-Ling Chen**, None; **Ming Wang**, None
Support: NIH Grant EY18385; EY018935

Program Number: 3053 **Poster Board Number:** D1075
Presentation Time: 8:30 AM - 10:15 AM
Intraocular Scattering Gradation from Double-Pass MTF Analysis
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Purpose: To objectively estimate the intraocular scattering by means of a new index (Frecuency Scattering Index, FSI), which is computed by using the whole double-pass (DP) image. The index proposed takes into account the maximum variation of the slope of the modulation transfer function (MTF) obtained from the DP image recorded.
Methods: We selected a group of 50 patients with different grades of nuclear cataracts, including from early to moderate stages according to the LOCS III classification system (from NO1 to NO3). A control group of 10 young normal eyes was also evaluated with the same procedure. DP images (size: 72 arc min) were obtained using a clinical instrument (OQAS, Visiometrics SL, Spain). From those images the FSI was computed by means of the corresponding MTF images and the analysis of their maximum slope. The FSI index was then compared with the OSI values (Objective Scatter Index) in terms of correlation. The OSI was provided by the OQAS instrument (Artal et al Plos 2011). The influence of low-order aberrations on the FSI was also analyzed by performing measurements on 8 healthy young subjects with induced defocus from -1.50 to +1.50 D in 0.25 D steps. These results were compared with those obtained by using the OSI parameter.
Results: For the control group and patients with different cataract grades, a statistically significant correlation ($r=0.726$, $p<0.001$) was found between the FSI and LOCS III classification. Mean FSI (±SD) was of 0.49±0.12 for the control group; 1.86±1.02 for the NO1 group; 2.47±1.12 for the NO2 group; and 3.35±1.67 for the NO3 group. FSI and OSI values also showed a good and significant correlation ($r=0.783$, $p<0.001$). Furthermore, none of the 8 subjects with induced defocus showed a variation in the FSI index higher than 0.7 within the tested range. In the case of the OSI, the range within which that was accomplished was between -1.50 and +1.00 D (Martinez-Roda et al. Clin Exp Optom 2011).
Conclusions: In this study a new index (FSI) to objectively estimate intraocular scattering by analyzing the slope variation in the MTF computed from the DP images is proposed. This index is computed using the complete DP image recorded and performs very well in discriminating different grades of nuclear cataracts. It has good correlations with the LOCS III clinical classification system and with the OSI parameter. FSI shows a high robustness regarding the induced defocus. Therefore, the FSI index could be a complementary and powerful tool in the objective assessment of intraocular scattering and thus for the improvement of cataract detection and surgery scheduling.
Commercial Relationships: **Joan Martinez-Roda**, None; **Meritxell Vilaseca**, None; **Juan Carlos Ondategui-Parra**, None; **Clemente Paz**, None; **Roberto F. Sanchez**, None; **Sergio Luque**, Visiometrics (P); **Jaume Pujol**, Visiometrics (P)
Support: "Ministerio de Educación y Ciencia", Spain and European Union (grant nº DPI2008-06455-C02-01); "Ministerio de Asuntos Exteriores y de Cooperación", Spain (grant nº D/030286/10).

Program Number: 3054 **Poster Board Number:** D1076
Presentation Time: 8:30 AM - 10:15 AM
Measuring Intraocular Scattering With Spatio-temporally Modulated Light
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Purpose: Light scattering in the human eye is an important factor influencing retinal image quality and quality of vision. The purpose of this study was to develop a new optical instrument based on the double-pass principle but using flicker optical heterodyne detection to measure intraocular scatter.
Methods: The instrument is a variation of a double-pass instrument using a specially designed source to be projected into the retina. The extended source was composed of four concentric annular diffusers back-illuminated by an array of 97 high-brightness green LEDs (530±10 nm). The LEDs corresponding to each annulus are temporally modulated at different frequencies ranging from 4 to 14 kHz. An annular diaphragm conjugated with the pupil plane allows light to enter the eye through an annulus with internal and external diameters of 4 and 5.5 mm respectively. A pupil camera controls the eye alignment. The retinal image of the source subtends a radius of 12 deg. Light reflected from the fundus is limited by a circular diaphragm conjugated with the pupil plane so that the incoming and outgoing pathways do not overlap. A pinhole conjugated with the retinal plane allows the light corresponding to the 15-arcmin central area of the retinal image to be detected by a photomultiplier tube. The Fourier transform of the photomultiplier signal reveals the contribution of each annulus and therefore the average intensity of scattered light between the corresponding angles. The system's sensitivity was evaluated by means of an artificial eye and previously calibrated diffusers.
Results: The system was capable of measuring the intensity of scattered light in three different regions (0.5-2, 3-5 and 6-12 deg of visual angle). The sensitivity was better that 0.1 log units of the equivalent straylight parameter -log(S)- for all angular regions. The Fourier method allowed the extraction of useful data for total exposure time equal to 300 msec.
Conclusions: An instrument to measure scattering based in the double-pass method with improved heterodyne-type optical detection has been developed and validated in an artificial eye model. A high sensitivity was demonstrated by using diffusers that create comparable scatter to that expected in healthy young eyes. The system is compact and could be of use in future clinical applications.
Commercial Relationships: **Onurcan Sahin**, None; **Harilaos S. Ginis**, Universidad de Murcia, P201130670 (P); **Guillermo M. Perez**, Universidad de Murcia, P201130670 (P); **Juan M. Bueno**, Universidad de Murcia, P201130670 (P); **Pablo Artal**, Universidad de Murcia, P201130670 (P)
Support: "Ministerio de Educación y Ciencia", Spain (Grant FIS2010-14926) and "Fundación Séneca", Murcia, Spain (grant 04524/GERM/06) and by EU , ITN OpAL (PITN-GA-2010-264605).

Program Number: 3055 **Poster Board Number:** D1077
Presentation Time: 8:30 AM - 10:15 AM
Wavelength Dependence Of Intraocular Scatter Assessed With An Optical Method
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Purpose: Intraocular light scattering depends on the wavelength due to the physical properties of different inhomogeneities in the ocular media. This could in principle be used to the early diagnosis of underlying pathologies. Toward a practical application of this concept, a baseline characterization of the scatter wavelength