Program Number: 813 **Poster Board Number:** D961
Presentation Time: 11:15 AM - 1:00 PM
Interferometric Measurements of Aberrations In Isolated Human Crystalline Lenses
Eva Acosta[1], Christina Schwarz[2], Juan M. Bueno[2], Jose M. Marin[3], Pablo Artal[2]. [1]Applied Physics, Univ of Santiago de Compostela, Santiago de Compostela, Spain; [2]Laboratorio de Optica, Universidad de Murcia, Murcia, Spain; [3]Servicio de Oftalmologia, Hospital Virgen de la Arrixaca, Murcia, Spain.
Purpose: To analyze the nature of aberrations in isolated human crystalline lenses from interferometric measurements. Deviation from a symmetric model and the contribution of significant aberrations will be specifically studied.
Methods: A custom-built point-diffraction interferometer (PDI) has been used to measure wavefront aberrations in a number of isolated crystalline lenses from human donors (ages ranging from 35 to 45). The PDI technique is based on recording the interference between a reference spherical beam generated by diffraction from a clear pinhole in a semitransparent coated plate and the beam under test focused in the vicinities of the pinhole. Crystalline lenses were kept within the ocular globe (without corneas) in a culture medium inside an appropriate container until analysis a few hours after post-mortem. For the measurements, lenses were excised and inserted in a glass cell with plane-parallel faces filled with the same culture medium. The lens anterior surface was illuminated with a monochromatic (633 nm) plane wave and several interferograms recorded with a CCD camera. Dark fringes of the interference patterns were tracked semi-automatically for direct fitting of phase to a minimum set of significant Zernike polynomials to reconstruct the lenses' wavefront aberrations.
Results: For all tested lenses, the 36 Zernike polynomials which sum of radial and azimuthal frequency was equal to or smaller than 10 were significant in the fit. This means that even spherical aberration of order 10th was needed to accurate fit the interferometric data. Moreover, 4th order spherical aberration had negative values for all specimens, with a mean value of -0.6 wavelengths peak-to-valley. On average the contribution to total aberration of the non-rotational aberrations was smaller than 3 wavelengths peak-to-valley, being the dominant terms the second order astigmatism (2, ±2), and (4, ±2) as well as coma (3, ±1), (5, ±1), (7, ±1) and (9,±1). Trefoil and quadrafoil terms were required for accurate fits, but had a lower impact. Conversely, pentafoil terms (5, ±5) were non significant for the fit.
Conclusions: Wavefront aberrations of isolated human crystalline lenses have been measured within a root-mean-square error better than 0.2 wavelengths with an interferometric method. These results provide a better insight into the aberration structure of the human crystalline lens.
Commercial Relationships: Eva Acosta, None; **Christina Schwarz**, None; **Juan M. Bueno**, None; **Jose M. Marin**, None; **Pablo Artal**, None
Support: supported by grants nº FIS2007-63123, FIS2007-64765; CSD2007-00033 SAUUL, 4524/GERM/06 and FIS2010-16753.

Program Number: 814 **Poster Board Number:** D962
Presentation Time: 11:15 AM - 1:00 PM
Changes in Primate Crystalline Lens Volume During Simulation of Accommodation in a Lens Stretcher
Lauren K. Marussich[1,2], Derek Nankivil[1], Bianca M. Maceo[1,2], Esdras Arrieta[1], Raksha Urs[1,2], Fabrice Manns[1,2], Arthur Ho[3,4], Robert C. Augusteyn[5], Jean-Marie A. Parel[1,5]. [1]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, Univ of Miami Miller School of Medicine, Miami, FL; [2]Biomedical Optics and Laser Laboratory, Department of Biomedical Engineering, Univ of Miami, College of Engineering, Coral Gables, FL; [3]Brien Holden Vision Institute, Sydney, Australia; [4]School of Optometry and Vision Science, University of New South Wales, Sydney, Australia; [5]Vision Cooperative Research Centre, Sydney, Australia.
Purpose: To determine if the lens volume changes during accommodation in a lens stretcher.
Methods: 2 baboon lenses (3.1-9.6 years, PMT=2-24 hours) and 8 cyno lenses (1.4-9.1 years, PMT=3-50 hours) were mounted in a lens stretcher that simulates accommodation by applying radial forces (EVAS II, Ehrmann *et al*, *Clin Exp Opt*, 2008). The central cross-sectional lens shape in the unstretched state and at maximum stretch was measured using a custom-made time-domain Optical Coherence Tomography system (Uhlhorn *et al*, *Vis Res*, 2008). The lens volume was calculated using two different methods. In method 1, the lens is assumed to be an ellipsoid of revolution. In method 2, the lens contour is fit with an even Fourier cosine series (Urs *et al*, *Vis Res*, 2010) and the cross-sectional area is calculated. Volume is then calculated assuming that the lens is rotationally symmetric. The volumes in the stretched and unstretched states calculated using Methods 1 and 2 were compared using a Bland-Altman analysis.
Results: The cosine model provided a closer fit to the actual lens shape than the elliptical model. With method 1, the lens volume decreased by (5±11) mm^3 ($p = 0.112$). With method 2, the lens volume decreased by (2±4) mm^3 ($p = 0.109$). The elliptical model over-predicts the unstretched, stretched and change in volume by (13±7) mm^3 ($p<0.001$) (10±6) mm^3 ($p<0.001$) and (3±10) mm^3 ($p = 0.107$). The change in lens volume predicted by the cosine model for any baboon lens (95% PI) is less than 8% and not statistically significant.
Conclusions: The ellipsoid model overestimates the volume and change in lens volume during accommodation. There are no statistically significant changes in lens volume during accommodation in the EVAS II lens stretcher.
Support: NIH Grant 2R01EY14225, NIH Center Grant P30EY14801; the Australian Federal Government Cooperative Research Centres Program (Vision CRC); the Florida Lions Eye Bank; Research to Prevent Blindness; Henri and Flore Lesieur Foundation (JMP)
Commercial Relationships: Lauren K. Marussich, None; **Derek Nankivil**, None; **Bianca M. Maceo**, None; **Esdras Arrieta**, None; **Raksha Urs**, None; **Fabrice Manns**, None; **Arthur Ho**, None; **Robert C. Augusteyn**, None; **Jean-Marie A. Parel**, None
Support: NIH 2R01EY14225, P30EY14801; the Australian Federal Government Cooperative Research Centres Program (Vision CRC);Florida Lions Eye Bank;Research to Prevent Blindness;Henri & Flore Lesieur Foundation

Program Number: 815 **Poster Board Number:** D963
Presentation Time: 11:15 AM - 1:00 PM
Estimation of Central Average Group Refractive Index of Crystalline Lens from Optical Thickness Measurements
Arthur Ho[1,2], Fabrice Manns[3,4], Bianca Maceo[3,4], David Borja[3,4], Stephen Uhlhorn[3], Esdras Arrieta[3,4], Jean-Marie Parel[3,5]. [1]Brien Holden Vision Institute, Sydney, Australia; [2]School of Optometry & Vision Science, University of New South Wales, Sydney, Australia; [3]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, University of Miami Miller's School of Medicine, Miami, FL; [4]Biomedical Optics and Laser Laboratory, Dept of Biomedical Engineering, University of Miami, Coral Gables, FL; [5]Vision Cooperative Research Centre, Sydney, Australia.
Purpose: To determine the central/axial average group refractive index (AGRI) of the crystalline lens for the purpose of converting optical thickness measurements to geometrical thickness values. The age-dependency of AGRI was also investigated.
Methods: Isolated baboon (n=56, 1.8-28 y/o) and human lenses (n=103, 6-94 y/o) were imaged with either a custom-built time-domain OCT system (24 baboon, 53 human), or a shadow-photographic system (35 baboon, 51 human) fitted with a digital camera. From the OCT images, the central/axial optical path length (OPL) was extracted while from shadow-photographic images, the central thickness (CT) of lenses was measured. The quotient of the OPL to CT represents the AGRI of the lens along its central axis.
Results: The average AGRI was 1.414 and 1.450 for baboon and human lenses respectively. An age-dependency of AGRI was apparent in the lens of both species. The youngest age-range of the baboon lens returned an average AGRI of 1.362 while the oldest returned AGRI of 1.488. In human lenses, the 14-29 y/o group had AGRI of 1.443 while the oldest (60-69 y/o) had AGRI of 1.479. By algebraically combining two mathematical relationships obtained by linear regression between OPL and CT with age, age-dependency was found to be $AGRI=-4.770\times10^{-5}\,Age^2 + 4.834\times10^{-3}\,Age + 1.355$ for baboons and $AGRI=-6.852\times10^{-6}\,Age^2 + 1.826\times10^{-3}\,Age + 1.380$ for human.
Conclusions: Unlike previous studies, we find that the average group refractive index of baboon and human lenses increases with age. This increase with age is consistent with the formation of a refractive index plateau.
Commercial Relationships: Arthur Ho, None; **Fabrice Manns**, None; **Bianca Maceo**, None; **David Borja**, None; **Stephen Uhlhorn**, None; **Esdras Arrieta**, None; **Jean-Marie Parel**, None
Support: NIH Grant 2R01EY14225, Australian Government CRC Program (Vision CRC), NIH Center Grant P30EY14801, the Henri and Flore Lesieur Foundation (JMP), Florida Lions Eye Bank, Research to Prevent Blindness

Program Number: 816 **Poster Board Number:** D964
Presentation Time: 11:15 AM - 1:00 PM
Optomechanical Response of Primate Lenses: Effects of Decentration
Aaron C. Enten[1,2], Derek Nankivil[1], Bianca Maceo[1,3], Esdras Arrieta[1], Fabrice Manns[1,3], Jean-Marie Parel[1,4]. [1]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, FL; [2]Department of Biomedical Engineering, Johns Hopkins University, Baltimore, MD; [3]Biomedical Optics and Laser Laboratory, Department of Biomedical Engineering, University of Miami College of Engineering, Coral Gables, FL; [4]Vision Cooperative Research Centre, Sydney, Australia.
Purpose: To determine the effects of decentration on thickness, diameter, radius of curvature, and power measurements during lens stretching.
Methods: 6 post-mortem (16.3 ± 12.7 hours) eyes from 3 Cynomolgus monkeys (6.7 ± 0.5 years old) were dissected leaving intact the lens, zonules, ciliary body, and hyaloid membrane. The lens preparation was mounted and aligned in an optomechanical lens stretching system (Ehrmann *et al*, *Clin Exp Opt*, 2008) and the globe was stretched 2.5mm radially in 0.25mm increments. Load, lens diameter, and lens power were measured every 0.25mm. Lens thickness and anterior and

posterior radius of curvature were measured every 0.5mm using Optical Coherence Tomography (OCT) (Uhlhorn *el al*, *Vis Res*, 2008). The experiment was repeated on each eye with a manual realignment step after every measurement, and OCT doubled to record every 0.25mm.
Results: There was no significant difference ($p > 0.1$) between the values of the realigned run and the automatic run. The average change in thickness, anterior and posterior radius of curvature, posterior window distance, power, and diameter after realignment was (0.04 ± 0.08)mm ($p = 0.156$), (-0.13 ± 0.22)mm ($p = 0.213$), (-0.03 ± 0.06)mm ($p = 0.211$), (-0.02 ± 0.06)mm ($p = 0.342$), (0.07 ± 0.09)D ($p = 0.124$), and (0.02 ± 0.08)mm ($p = 0.538$) respectively.
Conclusions: All realigned eyes showed no statistical difference from automatic runs. Decentration during lens stretching results in less than 1% error in parameters measured by OCT, and manual realignment is not of sufficient precision to compensate for decentration during lens stretching.
Commercial Relationships: Aaron C. Enten, None; **Derek Nankivil**, None; **Bianca Maceo**, None; **Esdras Arrieta**, None; **Fabrice Manns**, None; **Jean-Marie Parel**, None
Support: Florida Engineering Foundation (AE), NIH 2 R01 EY14225, Florida Lions Eye Bank, Australian Government CRC Program, Research to Prevent Blindness, NIH P30 EY014801, Henri and Flore Lesieur Foundation

Program Number: 817 **Poster Board Number:** D965
Presentation Time: 11:15 AM - 1:00 PM
Elastic Properties Of Human Lens Zonules In Presbyopic Donor Eyes As A Function Of Age
Marek Mikielewicz, Carlos H. Gordillo, Gustavo A. Montenegro, Rafael I. Barraquer, Ralph Michael. Instituto Barraquer, Barcelona, Spain.
Purpose: To measure ex-vivo the stress-strain relationship of the human lens zonules.
Methods: Eleven presbyopic human donors eyes were classified by age in three groups (median age 60, 73 and 90 years) and measured in a device consisting of a rigid bench for holding and stretching coronal eye sections including the ciliary-lens zone. Radial stretching was created by a stepper motor coupled to a digital outside micrometer for linear displacement and distance measurement, and a digital balance for load measuring.
Results: Zonular elongation by 200 µm produced a mean load of 4.4; 3.3 and 2.8 mN in the different age groups (60, 73 and 90 years respectively). Increased elongation above physiological limits to 650 µm resulted in a mean load of 9.2; 6.9 and 6.2 mN, respectively. (10 mN = 1.02 g)
Conclusions: The force needed to stretch the human lens zonules decreases between the age of 60 to 90 years by about 30%.
Commercial Relationships: Marek Mikielewicz, None; **Carlos H. Gordillo**, None; **Gustavo A. Montenegro**, None; **Rafael I. Barraquer**, None; **Ralph Michael**, None
Support: None

Program Number: 818 **Poster Board Number:** D966
Presentation Time: 11:15 AM - 1:00 PM
Internal Crystalline Lens Structure Imaging using Long Range Optical Coherence Tomography
Carolina P. de Freitas[1], Marco Ruggeri[1,2], Bianca Maceo[1,2], Stephen Uhlhorn[1], Esdras Arrieta[1], Fabrice Manns[1,2], Robert Augusteyn[3], Arthur Ho[3], Jean-Marie Parel[1,3]. [1]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, FL; [2]Biomedical Optics and Laser Laboratory, Dept of Biomedical Engineering, University of Miami College of Engineering, Coral Gables, FL; [3]Vision Cooperative Research Center, Sydney, Australia.
Purpose: To demonstrate the feasibility of quantifying the internal human crystalline lens structure using Optical Coherence Tomography (OCT).
Methods: Eight isolated human lenses (31-90 y/o) were imaged with a custom-built time-domain system (Uhlhorn et al, Vis Res 2008) and 3 *in vivo* human lenses (24-34 y/o) were imaged with a custom-built extended-depth spectral-domain OCT system. The internal structure was analyzed qualitatively to determine if the zones of optical discontinuity that are seen in slit-lamp images can be detected. The nuclear and cortical thickness were measured. The cortical thickness was defined as the combined width of the C3, C2 and C1 zones which were determined by measuring the distance between local minima on the central A-line intensity profile. Optical distances were divided by published values of the average refractive index of the lens to produce true distances (Uhlhorn et al, Vis Res 2008).
Results: The lens structure is apparent in all isolated and *in vivo* lenses. The number of discrete zones of optical discontinuity is correlated with the age of the lens. For isolated lenses thicknesses ranged from 0.88-1.67mm for the anterior cortex, 0.72-1.17mm for the posterior cortex and 2.27-2.83mm for the nucleus. *In vivo* thicknesses ranged from 0.59-0.78mm for the anterior cortex, 0.83-0.90mm for the posterior cortex and 2.07-2.65mm for the nucleus. These values agree with previous in vivo Scheimpflug studies (Dubbelman et al, Vis Res 2003).
Conclusions: The study demonstrates the feasibility of imaging the zones of optical discontinuity of the *in vitro* and *in vivo* lenses using OCT.
Commercial Relationships: Carolina P. de Freitas, None; **Marco Ruggeri**, None; **Bianca Maceo**, None; **Stephen Uhlhorn**, None; **Esdras Arrieta**, None; **Fabrice Manns**, None; **Robert Augusteyn**, None; **Arthur Ho**, None; **Jean-Marie Parel**, None
Support: NIH Grant 2R01EY14225, NIH Center Grant P30EY14801; Australian Government's CRC Scheme (Vision CRC); the Henri and Flore Lesieur Foundation (JMP); Florida Lions Eye Bank; Research to Prevent Blindness

Program Number: 819 **Poster Board Number:** D967
Presentation Time: 11:15 AM - 1:00 PM
Application Of High Resolution Low Coherence Reflectometry To Track Ocular Biometric Changes During Disaccommodation
Amy L. Sheppard[1], Alison Alderson[2], Leon N. Davies[1], Edward A. Mallen[2]. [1]School of Life and Health Sciences, Aston University, Birmingham, United Kingdom; [2]Bradford School of Optometry, University of Bradford, United Kingdom.
Purpose: To utilise a high resolution optical low coherence reflectometry device (*LenStar*; Haag-Streit Koeniz, Switzerland) to track changes in ocular biometry during disaccommodation.
Methods: Ten pre-presbyopic subjects (5 female, 5 male; aged 22 to 40 years) participated in the study. Five measures of anterior chamber depth (ACD), lens thickness (LT) and axial length (AL) were acquired from the right eye whilst subjects viewed a 0 D, followed by a 5 D accommodative stimulus in a Badal system, which was visible through a pellicle mirror mounted at 45° in front of the *LenStar* measuring beam. Following the 5 D measures, stimulus demand was immediately reduced to 0 D and ocular biometric measures recorded at 5- 15 second intervals (depending on time required to adjust the instrument position between measurements) for one minute. The measurement process was performed three times on each subject. The speed of disaccommodative change for each biometric parameter was analysed by calculating and plotting the regression quotients of all measurements. An exponential decay function was fitted to the regression quotient data and used to determine the time period for biometric measures to regress to 90 % of the original (unaccommodated) level.
Results: During accommodation, ACD reduced by 0.21 ± 0.05 mm, whilst LT and AL measures increased by 0.243 ± 0.08 mm and 0.03 ± 0.02, respectively. There was broad variation between subjects in the time taken for biometric measures to regress to 90 % of the unaccommodated level (ranges: 4.65- 48; 4.40- 57.0 and 0.50- 59.0 seconds for ACD, LT and AL, respectively). No relationship was identified between subject age and 90 % regression time period for any of the parameters investigated ($P = 0.207$; 0.290 and 0.96, for ACD, LT and AL, respectively).
Conclusions: The *LenStar* device facilitates high-resolution measurements of changes in ocular biometry during disaccommodation. Further application of the technique will enable identification of the cause of nearwork-induced transient myopia in affected subjects.
Commercial Relationships: Amy L. Sheppard, None; **Alison Alderson**, None; **Leon N. Davies**, None; **Edward A. Mallen**, None
Support: None

Program Number: 820 **Poster Board Number:** D968
Presentation Time: 11:15 AM - 1:00 PM
An Individualised Finite-element Model of Accommodation Based on Direct Measurements
Austen M. Erickson[1,2], Fabian Conrad[2], Fabrice Manns[3,4], Derek Nankivil[3], David Borja[3], Esdras Arrieta-Quintero[3], Raksha Urs[5], Jean-Marie Parel[1,3], Arthur Ho[1,6]. [1]Vision Cooperative Research Centre, Sydney, Australia; [2]Brien Holden Vision Institute, Sydney, Australia; [3]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, Miami, FL; [4]Biomedical Optics and Laser Laboratory, Dept of Biomedical Engineering, University of Miami, Coral Gables, FL; [5]Dept of Ophthalmology, Columbia University Medical Center, New York, NY; [6]School of Optometry & Vision Science, University of New South Wales, Sydney, Australia.
Purpose: While finite element models (FEM) have been used to study accommodation, they have used geometric and mechanical property values based on sample-averages. We constructed an individualised FEM of accommodation based on direct measurements of an eye. With this FEM, we used a backward-calculation strategy to estimate the mechanical properties of the lens.
Methods: The lens, zonules, ciliary and sclera-ring of a baboon (age=7.8 yrs; PMT 26 hours) was mounted in a lens stretching system and stretched in a step-wise fashion (0.25 mm/step to 2.5 mm radially). At each step, load was recorded by tensometers and images were digitised to obtain lens profile, thickness and equatorial diameter and ciliary ring diameter. Lens contour was extracted, corrected for decentration and tilt then fit with an 11th-order even Fourier series.
Using the fitted contour, a 2-D axisymmetric FEM of the lens, assumed to have uniform mechanical properties and near incompressible (Poisson ratio, ν=0.499), was constructed (189 surface nodes). Meshing the geometry with quadrilateral elements (average edge length=0.05 mm), the FEM was stretched to a maximum of 0.76 mm ciliary displacement over 21 steps (maximum load=3 MPa). Values for the criteria variables (CV; lens thickness and diameter, and zonule length) were extracted and compared to those from measurements. E-modulus of the lens (EL) and capsule (EC) were varied to obtain the best match to the CV. Zonules E-modulus was maintained at 1.5 MPa.
Results: The moduli that returned the best match for lens diameter and zonule length were 0.375 MPa and 1.27 MPa for EL and EC respectively. With the

assumed ν, lens thickness could not be matched with these values requiring instead EL=0.167 MPa. Reducing ν to 0.3 returned an improved match to the CV.
Conclusions: An FEM customised to an individual eye based on direct measurement has been constructed. For the sample tested, the best match between model and measurements was obtained when the lens was allowed to be compressible.
Commercial Relationships: Austen M. Erickson, None; **Fabian Conrad**, None; **Fabrice Manns**, None; **Derek Nankivil**, None; **David Borja**, None; **Esdras Arrieta-Quintero**, None; **Raksha Urs**, None; **Jean-Marie Parel**, None; **Arthur Ho**, None
Support: NIH Grant 2R01EY14225; Australian Government CRC Program (Vision CRC), Florida Lions Eye Bank; NIH Center Grant P30EY14801; Research to Prevent Blindness; Henri and Flore Lesieur Foundation (JMP)

Program Number: 821 **Poster Board Number:** D969
Presentation Time: 11:15 AM - 1:00 PM
Evaluation of Key Parameters Providing Dioptric Power Change in an Optic-A Finite Element Analysis
Daniel G. Brady[1], Doug Cali[1], Henk A. Weeber[2], Ed Geraghty[1]. [1]Abbott Medical Optics, Inc, Santa Ana, CA; [2]R & D, AMO Groningen, Groningen, The Netherlands.
Purpose: The goal of this Finite Element Analysis (FEA) was to identify the key variables and their relative influence on optical power change for a deformable optic accommodating intraocular lens.
Methods: Non-linear static Finite Element Analysis was performed using Abaqus/Standard simulation software. Various optical-mechanical designs were modeled and evaluated for optic body deformation based on boundary conditions that simulated physiological force conditions. Boundary conditions consisted of 6gF that was applied either as a pressure to the outside surface of the optic (optic edge) or to an intermediate rigid surface that was in frictionless contact with the optic edge. Optical power was calculated using Abaqus output of pre and post deformation optic surface node coordinates for the central 3 mm optic zone. Optical surface data was imported into Zemax for optical quality analysis.
Results: The power change of the optic was affected by 4 key variables. The key variables identified were optic material mechanical properties, optic diameter, optic thickness and refractive index. The most significant variable found was the material mechanical property, i.e. Young's modulus, which when evaluated by FEA showed that materials,with low Young's moduli, produced relatively large optical power change when all other variables were held constant. A specific FEA model simulating a lens optic having a Young's modulus of 5.5kPa resulted in an optical power change of approximately 9D. The power change was also significantly increased by decreasing the optic diameter from 6 mm to 2mm. The thickness of the optic edge also had an affect on the power change of the optic, continuing to increase the power change of the optic up to 4D and leveled off at 5D. Lastly, Refractive index was also shown to be another factor in increasing the power change. The optical analysis using Zemax demonstrated that the optical quality can be maintained when the optic is compressed with 6gF.
Conclusions: The key variables of lens optic material mechanical property and center thickness identified in the FEA simulations show the potential to generate optical power change similar to that produced in the natural crystalline lens. Furthermore, when constrained by the physiological forces available within the eye lens optical materials with a Young's modulus between 10 to 100 kPA demonstrated optical power change similar to that of a healthy human crystalline lens with an approximated Young's modulus of 1.5 kPA.
Commercial Relationships: Daniel G. Brady, Abbott Medical Optics, Inc. (E); **Doug Cali**, Abbott Medical Optics, Inc. (E); **Henk A. Weeber**, Abbott Medical Optics, Inc. (E); **Ed Geraghty**, Abbott Medical Optics, Inc. (E)
Support: None

Program Number: 822 **Poster Board Number:** D970
Presentation Time: 11:15 AM - 1:00 PM
Incorporating Pre-stresses into a Capsular Bag Model
Brooke C. Basinger. Implant R&D, Abbott Medical Optics, Santa Ana, CA.
Purpose: To capture the natural stress equilibrium between the human capsular bag and crystalline lens in a finite element model.
Methods: Finite element models of the human crystalline lens and capsular bag were generated using Abaqus/Standard 6.10. Dimensions and material properties for a 29 year old lens were drawn from published data. No true stress-free reference state exists in the natural lens system so, for this model, the crystalline lens was initially modeled in the disaccommodated shape and the capsular bag in the accommodated shape. This represents a physiologically impossible geometry for the system as a whole, but provides a unique stress-free reference state for each part independently. Surface contact conditions were then manipulated to create an interference fit between the overlapping parts, forcing them to fit together.
Results: This approach results in a physiologically realistic equilibrium geometry in which both parts are constantly putting pressure on one another. The initial geometries for the two parts overlap and do not fit together, but once an interference fit is imposed, the model finds a pre-stressed equilibrium position which can then act as the initial state for later models. Von Mises stresses in the equilibrium position are on the order of 0.1 kPa in the crystalline lens and 20 kPa in the capsular bag, and the equilibrium geometry corresponds well with published descriptions of accommodated lens shape. Model behavior in response to cilliary forces is consistent with published experimental data.
Conclusions: Modeling the capsular bag and crystalline lens in separate stress-free reference geometries and then enforcing an interference fit between the parts results in an equilibrium state that captures the natural mechanical equilibrium between the two. Including these pre-stresses in a model provides a more physiologically realistic representation of the capsular bag that can be used to further our understanding of the effects of aging, changing tissue properties, and surgical intrusions on accommodation, and to guide development efforts for accommodating IOLs.
Commercial Relationships: Brooke C. Basinger, Abbott Medical Optics, Inc. (E)
Support: None

Program Number: 823 **Poster Board Number:** D971
Presentation Time: 11:15 AM - 1:00 PM
Evaluation of the Capsular Bag Diameter with a Modified Capsular Tension Ring in Human Donor Eyes Using the Miyake-Apple Technique
Rakhi Jain[1], Liliana Werner[2], Nick Mamalis[2]. [1]Implant R&D, Abbott Medical Optics Inc., Santa Ana, CA; [2]Department of Ophthalmology, John A. Moran Eye Center, University of Utah, Salt Lake City, UT.
Purpose: The goal of this ex vivo study was to compare the measurements of empty capsular bag diameter of human cadaver eyes using a modified capsular tension ring system and surgical calipers, using the Miyake-Apple technique.
Methods: A total of 9 human cadaver eyes (age range: 48 to 75 years) were used in this study. White-to-white diameter, equatorial diameter and axial length were measured and anterior chamber depth was measured using ultrasound biomicroscopy (UBM). The globes were prepared for surgery using the Miyake-Apple technique and, after removal of the cornea and iris, the capsular bag diameter was measured in two meridians with surgical calipers before and after lens extraction. After the modified capsular tension ring was implanted, the capsular bag was measured in two meridians using calipers as well as the ring measurement system.
Results: The mean natural lens diameter of the human eye was 9.57 mm (range: 9.2 - 9.95 mm). The mean capsule bag diameter increased slightly after lens extraction to 9.75 mm (range 9.6 - 9.85). The mean capsular bag diameter measured with the modified capsular tension ring using the ring measurement system/viscoelastic was 10.32 mm (range: 10.0 mm to 10.65 mm). There was no difference in the measurements (no measurement variation greater than 0.1 mm) of the empty capsular bag with the ring with and without viscoelastic. The capsular bag diameters measured with ring measurement system/viscoelastic were slightly larger than the measurements with surgical calipers (mean 10.11 mm, range: 9.9 - 10.4 mm).
Conclusions: It is difficult to measure the diameter of the evacuated capsular bag in vivo. The modified capsular tension ring system may be used to measure the capsular bag diameter intra-operatively. In the peer-reviewed literature, it is well understood that the sizing of accommodating intraocular lenses (IOLs) is a critical parameter in optimal performance. The modified capsular tension ring system may aid in the understanding of IOL sizing and optimization of accommodative amplitude.
Commercial Relationships: Rakhi Jain, Abbott Medical Optics Inc. (E); **Liliana Werner**, Abbott Medical Optics Inc. (C); **Nick Mamalis**, Abbott Medical Optics Inc. (C)
Support: None

Program Number: 824 **Poster Board Number:** D972
Presentation Time: 11:15 AM - 1:00 PM
Heine Lambda 100 Retinometer in Prognosis of Nuclear Lens Opacity
Guilherme C. Barboza, Marcello C. Barboza, luiz Roberto C. Barboza, Maria Margarida C. Barboza, Wilson T. Hida. Ophthalmology, Hospital Visao Laser, Santos, Brazil.
Purpose: Compare potential visual acuity obtained before cataract surgery using Heine Lambda 100 retinometer with best corrected visual acuity 6 months postoperatively in nuclear lens opacification
Methods: Prospective study executed in the Ophthalmology Hospital Laser Vision in Santos of 121 eyes of 83 patients who underwent cataract surgery (phacoemulsification with intraocular lens implantation), from May to August, 2010. In the preoperative period, Heine retinometer test was performed under mydriasis and its results were compared to postoperative best corrected visual acuity 6 months after surgery and correlated with nuclear lens opacification, being considered a satisfactory result those who did not vary more than two lines in Snellen char
Results: The satisfactory cases found in our study were 86.78%, with results of visual acuity with Heine retinometer equal to the postoperative visual acuity in 34.7% of the cases. Predominant nuclear opacity N1+ has a higher reliability than N2+ and N3+ (50%, 31.3% and 26.7%, respectively). Regarding all studied eyes, statistical significance was noted ($p<0.0001$).
Conclusions: In most cases Heine retinometer underestimated or maintained best

corrected visual acuity 6 months postoperatively in patients who underwent cataract surgery with nuclear lens opacification.
Commercial Relationships: Guilherme C. Barboza, None; **Marcello C. Barboza**, None; **luiz Roberto C. Barboza**, None; **Maria Margarida C. Barboza**, None; **Wilson T. Hida**, None
Support: None

Program Number: 825 **Poster Board Number:** D973
Presentation Time: 11:15 AM - 1:00 PM
3-dimensional Lens Densitometry Measured With Scheimpflug Imaging In Eyes With Cataract
Takushi Kawamorita[1,2], Hiroshi Uozato[1,2], Yoshihiko Iida[3], Nanami Nakayama[2], Yuko Shibata[2], Maki Shindo[2], Kimiya Shimizu[3,2]. [1]Orthoptics and Visual Science, Kitasato University School, Sagamihara, Japan; [2]Ophthalmology and Visual Science, Kitasato University Graduate School of Medical Sciences, Sagamihara, Japan; [3]Ophthalmology, Kitasato University School of Medicine, Sagamihara, Japan.
Purpose: To assess the average lens density (ALD) covering 360 degrees and the nuclear lens density (NLD) using the Scheimpflug densitometry and to determine their correlation with best-corrected visual acuity, and lens grading based on the Emery and Little classification.
Methods: Fifty three eyes (40 cataract and 13 clear lenses) from 53 subjects (mean 57.3 ± 22.0 years) were included in the study. 360 degrees lens density measurements were performed with Pentacam device (Oculus, Germany), which is comprised of a rotating Scheimpflug camera and short-wavelength slit light. Following lens densitometry metrics were evaluated: NLD at which lens densitometry is greatest on a horizontal cross-section; 3-dimensional (3D), in which a fixed, circular 1.0 mm (NLD 1.0 mm) and 3.0 mm (NLD 3.0 mm) areas of the lens are selected and a mean lens densitometry value given.
Results: The densities of the lens in all metrics were increasing with higher grades. The NLD in the Emery Grade 0, 1, 2 and 3 were 7.3 ± 2.0, 12.7 ± 1.7, 16.6 ± 5.7, and 22.8 ± 8.1, respectively. The ALD 1.0 mm in the Emery Grade 0, 1, 2 and 3 were 9.4 ± 1.3, 13.3 ± 1.8, 15.4 ± 2.7, and 17.5 ± 2.5, respectively. The ALD 3.0 mm in the Emery Grade 0, 1, 2 and 3 were 9.1 ± 1.2, 12.3 ± 1.5, 14.0 ± 2.2, and 15.7 ± 1.6, respectively. Also, best-corrected visual acuity significantly correlated with NLD ($r = 0.635$; $p < 0.001$), ALD 1.0 mm ($r = 0.712$; $p < 0.001$) and ALD 3.0 mm ($r = 0.742$; $p < 0.001$). .
Conclusions: The 3-D lens densitometry using Pentacam device could be helpful for follow-up of cataracts, and could be a potential tool for prediction of visual acuity in cataract patients, although further studies are needed to clarify the effects of cataracts on visual performance.
Commercial Relationships: Takushi Kawamorita, None; **Hiroshi Uozato**, None; **Yoshihiko Iida**, None; **Nanami Nakayama**, None; **Yuko Shibata**, None; **Maki Shindo**, None; **Kimiya Shimizu**, None
Support: This work was supported by KAKENHI 22791683; Grant-in-Aid for Young Scientists (B)

Program Number: 826 **Poster Board Number:** D974
Presentation Time: 11:15 AM - 1:00 PM
Presbyopia is the First Stage of Nuclear Cataract-Analysis of Forward and Backward Scattered Straylight in the Presbyopic Human Lens
Kathleen S. Kunert[1], Monique Nennstiel[1], Marcus Blum[1], Stefan Schramm[2], Bernd-Ulrich Seifert[2], Patrick Schikowski[2], Juergen Prehl[2], Monika Reder[1]. [1]Department of Ophthalmology, HELIOS Klinikum Erfurt, Erfurt, Germany; [2]Biomedical Engineering and Informatics, Ilmenau University of Technology, Germany.
Purpose: The study was conducted as a prospective clinical pilot study to analyse ocular straylight in presbyopia. Changes in the lens with presbyopia might not only result in a loss of accommodation but also in a reduced visual performance due to straylight induced by the lens.
Methods: A total of 139 patients (278 eyes) were examined and divided by age (y) into the three following groups: (G1-praepresbyopic-18-35 y; G2-presbyopic-36-50 y; G3-accommodative loss-51-80 y). Two methods were used to measure ocular straylight. First, backward scattered light was evaluated using the Pentacam High Resolution. Second, forward scattered light was subjectively measured with the C-Quant (both instruments from Oculus Optikgeräte GmbH, Germany). Besides, visual acuity was measured with EDTRS-charts and accommodative amplitude with the WAM-5500 (Grand Seiko Co. Ltd., Japan). Differences between the age groups were investigated using the Mann-Whitney-U-test.
Results: Measurement of backward scattered straylight using the Pentacam-Scheimpflug method (linear densitometry) revealed significant differences between all age groups: An increase in the densitometric value D_{max} was seen between G1-G2 ($p < 3.6\ e^{-14}$), G1-G3 ($p < 0.0001$) and G2-G3 ($p < 0.0001$). The measurement of the subjective forward scattered straylight also showed a significant increase with age. Differences were again significant for all three groups: G1-G2 ($p < 0.03$), G1-G3 ($p < 0.0001$) and G2-G3 ($p < 5.3\ e^{-09}$). For both methods, significances were seen already at the stage of presbyopia. Visual acuity was significantly reduced between G1-G3 ($p < 0{,}001$), but not between G1-G2. Accommodative amplitude declined with age as expected.
Conclusions: The increase of ocular straylight is reproducibly dependent on age. A significant increase in straylight can be demonstrated at the stage of presbyopia even though visual acuity remains unaffected and accommodative effort of the lens is not yet collapsed.
Commercial Relationships: Kathleen S. Kunert, None; **Monique Nennstiel**, None; **Marcus Blum**, None; **Stefan Schramm**, None; **Bernd-Ulrich Seifert**, None; **Patrick Schikowski**, None; **Juergen Prehl**, None; **Monika Reder**, None
Support: BMBF FKZ 13N8835A

Program Number: 827 **Poster Board Number:** D975
Presentation Time: 11:15 AM - 1:00 PM
Forward Light-scatter By Opacified Posterior Capsules Isolated From Pseudophakic Donor Eyes
Maartje C. van Bree[1], Ivanka J. van der Meulen[2], Luuk Franssen[3], Joris E. Coppens[3], Nicolaas J. Reus[4], Bart L. Zijlmans[4], Thomas J. van den Berg[3]. [1]Rotterdam Ophthalmic Institute, Rotterdam, The Netherlands; [2]Academic Medical Center, Amsterdam, The Netherlands; [3]Netherlands Institute for Neuroscience, Royal Netherlands Academy, Amsterdam, The Netherlands; [4]The Rotterdam Eye Hospital, Rotterdam, The Netherlands.
Purpose: Posterior capsule opacification (PCO) degrades visual function not only by reducing visual acuity, but also by increasing intraocular light-scatter. We used an in-vitro model to elucidate the effect of PCO-morphology on light-scatter and the functional aspect of light-scatter, as can be measured in the clinical setting by means of straylight.
Methods: Capsular bags were isolated from pseudophakic human donor bulbi. Using a goniometer setup and a camera, forward PCO-scatter was recorded. The camera position mimicked the anatomical position of the retinal photoreceptors; the camera recorded the scattered light that the photoreceptors would sense in an in-vivo situation. Scattered light was recorded at different wavelengths and scatter-angles ($\theta > 1°$), which were divided into a near ($\theta \leq 7°$) and far ($\theta > 7°$) large-angle domain. The camera used the scattered light to produce grayscale images of PCO. Scatter intensities were interpreted in terms of straylight and compared to the straylight part of the point-spread function of the normal eye.
Results: Depending on morphology and severity, PCO-scatter could differ considerably in intensity. The scatter-intensity of PCO and the normal eye can also differ substantially, whereas their angular dependence is approximately the same. PCO-scatter shows the type of wavelength dependence that is normal for small particles: monotonically decreasing with increasing wavelength. These similarities changed somewhat at the near large-angle domain, where the angular and wavelength characteristics of PCO-scatter differed slightly from those of the normal eye.
Conclusions: Surprisingly, the angular dependence of PCO-scatter is comparable to that of the normal eye, suggesting similar underlying scattering processes. The data demonstrate that, apart from scatter, PCO has a refractile component, which dominates at the near large-angle domain and is most pronounced in pearl-type PCO.
Commercial Relationships: Maartje C. van Bree, None; **Ivanka J. van der Meulen**, None; **Luuk Franssen**, None; **Joris E. Coppens**, None; **Nicolaas J. Reus**, None; **Bart L. Zijlmans**, None; **Thomas J. van den Berg**, None
Support: Dutch grant ISO 62031

Program Number: 828 **Poster Board Number:** D976
Presentation Time: 11:15 AM - 1:00 PM
Accommodation In Rhesus Monkeys Measured By Full-field Infrared Photorefraction
Lin He, Mark Wendt, Adrian Glasser. College of Optometry, University of Houston, Houston, TX.
Purpose: Interest has grown in understanding the relationship between peripheral refraction and accommodation. Photorefraction has been used to measure full-field refraction in humans. Here, a new approach has been developed to measure full-field refraction and accommodation in anesthetized rhesus monkeys.
Methods: To do full-field photorefraction, a camera positioned 30 cm in front of the eye was attached to a rod that was rotated in a horizontal arc with the eye at the center of curvature of the arc. A potentiometer with a DC power supply was attached to the pivot point of the rod so the potentiometer resistance changed proportionally with the angle. The analog output from the potentiometer enabled dynamic recording of the angle of rotation through an A/D converter. A real-time Matlab application was developed to acquire and analyze photorefraction images and simultaneously measure the rotation angle at 30 Hz. Full-field, trial-lens photorefraction calibrations were compared with on-axis calibrations. In six monkeys (including two repeats of one monkey) (ages: 11.3 to 13.6 y, mean±SD: 12.8±0.9 y) full-field refraction measurements were performed before and during carbachol iontophoresis stimulated accommodation.
Results: The Matlab photorefraction application had less than 0.1 D of variance and allowed eccentricity measurements with angular resolution of 0.1°. Photorefraction of the monkey eyes was measureable from at least -30º to 30º over 20 seconds. In five monkeys that showed linear calibration functions ($r2 > 0.85$), the full-field calibration was mostly consistent with on-axis calibration, but at some eccentricities for some eyes, the calibrated slopes either increased by up to 2% or decreased by up to 25%. On axis accommodative responses ranged from 5.82 D to 14.30 D (mean±SD: 9.14±3.96 D). Within the 60º field, the off-axis accommodative responses varied from the on-axis response by -1.17±2.02 D to

+3.07±2.85 D. Relative to the on-axis accommodation, temporal retinal fields tended to have larger accommodation changes (mean=3.07 D) compared to the nasal fields (mean=0.77 D).
Conclusions: This system is capable of reliably measuring dynamic, full-field refraction reproducibly in anesthetized monkeys. The drug stimulated accommodative response was relatively uniform across the central 10° visual field, but varied more peripherally and non-symmetrically between nasal and temporal fields.
Commercial Relationships: Lin He, None; **Mark Wendt**, None; **Adrian Glasser**, None
Support: NIH P30 EY07551

Program Number: 829 **Poster Board Number:** D977
Presentation Time: 11:15 AM - 1:00 PM
Influence of Accommodation and Gaze Angle on Primary and Secondary Spherical Aberration Over Time
Michael J. Collins[1], Atanu Ghosh[1], Scott A. Read[1], Brett A. Davis[1], Robert Iskander[2], Payel Chatterjee[1]. [1]School of Optometry, Queensland University of Technology, Brisbane, Australia; [2]Institute of Physics, Wroclaw University of Technology, Wroclaw, Poland.
Purpose: To investigate the stability of wavefront aberrations between primary gaze and downward gaze with the same level of accommodation (2.5 D) over a period of time.
Methods: Twenty five young subjects (mean age 25 ± 4 years) were recruited. Subjects watched TV at 5 m distance in primary gaze for 10 mins duration prior to each trial and then performed a binocular near (40 cm) task (watching video on a portable LCD screen) in both primary (0°) and downward gaze (25°) in separate trials. Wavefront measurements were taken using a modified Shack-Hartmann aberrometer that allowed free space viewing of a target (high contrast Maltese cross) displayed on the LCD screen in both primary and downward gaze. Measurements were taken immediately (<1 min), 5 and 10 mins after the commencement of each trial from the subject's left eye. Zernike coefficients up to the 8th radial order were analysed (fixed 3.0 mm pupil).
Results: Repeated measures ANOVA revealed a significant effect of gaze (p=0.004) and a significant gaze by time interaction (p=0.046) for the changes in primary spherical aberration C(4,0) during accommodation. C(4,0) was significantly more negative in downward gaze, with the largest differences between primary and downward gaze (-0.013 µm) noted at the 10 mins measurement. A significant influence of gaze (p=0.02) was also found for secondary spherical aberration C(6,0) during accommodation. Refractive power analysis showed that the changes in primary and secondary spherical aberration resulted in more negative longitudinal spherical aberration with downward gaze that increased with time during the 2.5 D accommodation task. Defocus showed no obvious change between primary and downward gaze during the 10 mins near task (p=0.409).
Conclusions: Significant changes in primary and secondary spherical aberration occurred between primary and downward gaze for a moderate level of accommodation. The difference in spherical aberration between primary and downward gaze systematically increased over the 10 mins near task.
Commercial Relationships: Michael J. Collins, None; **Atanu Ghosh**, None; **Scott A. Read**, None; **Brett A. Davis**, None; **Robert Iskander**, None; **Payel Chatterjee**, None
Support: None

Program Number: 830 **Poster Board Number:** D978
Presentation Time: 11:15 AM - 1:00 PM
Effects of Atropine on the Accommodative System
Noelle S. Matta, David I. Silbert. Vision Science Department, Family Eye Group, Lancaster, PA.
Purpose: We set out to determine the accommodative effects of Atropine on the visual system.
Methods: A prospective study was done on a normal eye in a 31-year-old cooperative adult. One drop of Atropine was instilled and the effect on accommodation, near visual acuity and pupil size was recorded. Accommodation was measured at 1/3 of a meter utilizing the Grand Seiko Auto Refractor. Near visual acuity was measured with the PEDIG ATS 4 near visual acuity test at a set distance of 16 inches.
Results: Atropine caused its greatest effect to accommodation, and to pupil size, 3 hours after installation. Curiously, the greatest effect on near visual acuity was seen 27 hours after instillation at which time it dropped to 20/80. Near visual acuity had improved to 20/25 on day 4. Accommodation returned to normal 8 days after instillation and pupil size returned to normal 12 days after instillation.
Conclusions: One drop of Atropine affected accommodation for 8 days. Despite this, near vision returned to 20/20 by day 5. These findings may impact how Atropine is prescribed to treat amblyopia both to maximize effectiveness and minimize its impact on school performance.
Commercial Relationships: Noelle S. Matta, None; **David I. Silbert**, None
Support: None

Program Number: 831 **Poster Board Number:** D979
Presentation Time: 11:15 AM - 1:00 PM
Effect of Pupil Miosis on Accommodation Measurements
Jesson Martin[1A], Norberto Lopez-Gil[2], Tao Liu[1A], Arthur Bradley[1A], Larry N. Thibos[1B]. [A]School of Optometry, [B]Optometry, [1]Indiana University, Bloomington, IN; [2]Ciencias de la Vision, Universidad de Murcia, Murcia, Spain.
Purpose: Accommodative miosis is a natural decrease of pupil size during accommodation. We investigated the effect of miosis on the measurement of refractive state and accommodation.
Methods: An optical bench fitted with a modified aberrometer (COAS, Wavefront Sciences Inc.) was used to obtain wavefront aberration measurements in the right eyes of 5 non-presbyopes during accommodation. Vergence of the visual stimulus (Landolt C) ranged from +0.5 to -4.5 D relative to the eye's far-point. To ensure accurate accommodation during aberrometry, measurements were obtained when the subject was correctly reading letters near their own personal resolution limit. The experiment was performed monocularly with and without pharmacological dilation of the pupil. Pupil dilation without cycloplegia was achieved by instilling one or two drops of phenylephrine. Refractive state of the eye was measured 2 ways: (1) by the Zernike coefficient C20 for defocus (which specifies the target vergence required for optimal focusing of the circle-of-least-confusion on the retina); and (2) by the Seidel coefficient W20 (which specifies the target vergence required for optimal focusing of paraxial rays).
Results: On average, the natural pupil constricted 1.9 mm in diameter for the nearest target. For dilated pupils, the change in refractive state produced by the accommodative stimuli was higher for the Seidel criterion than for the Zernike criterion. This finding is consistent with the reversal of sign of spherical aberration (Zernike coefficient C40) when the crystalline lens changes shape during accommodation. For natural pupils this discrepancy between Zernike and Seidel measures of accommodative response decreased as a consequence of a reduced impact of spherical aberration for naturally constricted pupils.
Conclusions: Measured changes in ocular refractive state during accommodation depend on the method of measurement and also pupil size. Different methods converge to a common value as the pupil constricts due to accommodative miosis. Thus pupil size will affect traditional measures of accommodative amplitude, accommodative gain, lead and lag.
Commercial Relationships: Jesson Martin, None; **Norberto Lopez-Gil**, None; **Tao Liu**, None; **Arthur Bradley**, None; **Larry N. Thibos**, None
Support: NIH 46-355-07

Program Number: 832 **Poster Board Number:** D980
Presentation Time: 11:15 AM - 1:00 PM
Impact Of Lens-induced Anisometropia On Accommodative Responses To Step And Ramp Stimuli In Adults
Shrikant R. Bharadwaj[1A], Vaishnavi Raghuram[1B], Vivek Labhishetty[1B]. [A]Hyderabad Eye Research Fndtn, [B]Bausch & Lomb School of Optometry, [1]L V Prasad Eye Institute, Hyderabad, India.
Purpose: Despite large inter-ocular differences in retinal image quality induced by anisometropia, adult accommodative responses to ramp changes in stimulus position (i.e. for gradual temporal changes in retinal blur) are only marginally smaller with induced anisometropia than habitual binocular viewing. To determine if this immunity to induced anisometropia also exists for step changes in stimulus position (i.e. for large instantaneous changes in retinal blur), this study compared accommodative performance to step and ramp stimuli in the presence of transiently induced myopic and hyperopic anisometropia.
Methods: Individually calibrated accommodative responses from both eyes of 8 emmetropic adults (19.2 to 28.4yrs) were recorded using a dynamic (30Hz) infrared photorefractor. Subjects watched high-contrast 20/40-sized letters on an LCD screen under four conditions: i) habitual binocular viewing, ii and iii) with +3.25D or -3.25D lens over right eye (induced myopic and hyperopic anisometropia, respectively) and iv) monocular viewing (right eye covered with an IR filter). In the ramp condition, the LCD screen moved between 55 and 30cm (1.5D demand) at 0.2D/s, with 4s stable period at each distance. In the step condition, the stimulus was switched electronically between two LCD screens placed at 55cms and 30cms, with a 4s stable period at each distance. Both eyes were dilated with 5% PHCl to maintain pupil size within the operating range of photorefractor.
Results: Mean (±1SD) left eye's accommodative response was largest under binocular condition (Ramp: 1.08±0.22D; Step: 1.10±0.23D), followed by monocular condition (Ramp: 0.96±0.29D; Step: 1.00±0.29D), -3.25D aniso condition (Ramp: 0.92±0.26D; Step: 1.01±0.26D) and +3.25D aniso condition (Ramp: 0.88±0.32D; Step: 0.95±0.34D). 2-factor ANOVA showed no statistically significant main effect of viewing condition (p=0.18) or stimulus movement (p=0.06). Accommodative responses of both eyes were consensual under all viewing conditions in 7 of the 8 subjects.
Conclusions: Marginal reduction in the size of ramp accommodative responses with ±3.25D of induced anisometropia is similar to earlier observations. Similar accommodative responses to ramp and step stimuli indicates that the rate of change of retinal blur has no significant influence on how induced anisometropia impacts accommodative performance. Consensual accommodation with induced anisometropia suggests that most subjects did not employ a monovision-type focusing strategy for either the step or ramp stimuli.
Commercial Relationships: Shrikant R. Bharadwaj, None; **Vaishnavi Raghuram**, None; **Vivek Labhishetty**, None
Support: DBT Ramalingaswamy fellowship to SRB

Program Number: 833 **Poster Board Number:** D981
Presentation Time: 11:15 AM - 1:00 PM
Accommodation as a Function of Anterior Segment Biometry
Yimin Yuan[1], Yan Lian[1], Yilei Shao[1], Fan Lu[1], Meixiao Shen[2], Jianhua Wang[2], Aizhu Tao[1]. [1]School of Ophthalmology and Optometry, Wenzhou Medical College, Wenzhou, China; [2]Ophthalmology, Bascom Palmer Eye Institute, Miami, FL.
Purpose: To investigate the relationship between the induced accommodation and anterior segment biometry using an ultra-long scan depth spectral domain optical coherence tomography (UL-OCT).
Methods: Ten young healthy subjects (7 women and 3 men, mean ± SD age: 24.1 ± 2.47 years) were recruited. Each subject was required to fix an external target with the left eye. The target was moved towards the subject to induce various accommodative stimuli from 0 to 5.50D gradually by a 0.50D increment. A custom UL-OCT (7.8 mm scan depth and 6μm axial resolution) was used to image the entire anterior segment with both mirror images. The right eye during non-accommodative and various accommodative conditions was imaged. Custom algorithms were developed to use both mirror images to obtain a full range of the entire anterior segment (15.6mm scan depth equivalent). After image correction, the software yielded biometric dimensions, including anterior chamber depth (ACD), pupil diameter (PD), lens thickness (LT), anterior (ASC) and posterior (PSC) surfaces curvatures of the lens.
Results: Within 1.00D accommodation stimuli, the changes of ACD, ASC, PSC and LT were similar (Re-ANOVA and post hoc test, $P > 0.05$). With increased accommodative stimuli more than 1.00D, ACD, and the radii of ASC and PSC were found significantly decreased compared to the non-accommodative condition ($P < 0.01$). The LT was found significantly increased ($P < 0.05$). Negative correlations of the induced accommodative stimuli were found with ACD, and the radii of ASC and PSC (r range: 0.87 - 0.99, $P < 0.01$). The induced accommodative stimulus was positively correlated with LT ($r = 0.98$, $P < 0.01$).
Conclusions: It appeared that the increased accommodation (more that 1.00D) is a function of the anterior segment biometric dimensions, which may provide useful information on modeling the accommodation system. The UL-OCT holds the promise for studying accommodation on human eye.
Commercial Relationships: Yimin Yuan, None; **Yan Lian**, None; **Yilei Shao**, None; **Fan Lu**, None; **Meixiao Shen**, None; **Jianhua Wang**, None; **Aizhu Tao**, None
Support: Technology Development Supporting Program of the Eleventh Five-Year Plan, Beijing, China

Program Number: 834 **Poster Board Number:** D982
Presentation Time: 11:15 AM - 1:00 PM
Effect Of Low Accommodative Demand On Higher Order Aberrations Of The Lens
Rebecca K. Zoltoski[1A], Jennifer Harthan[1B], Kyle Klute[1], Marc Landes[1], Jer R. Kuszak[2]. [A]Didactic Education, [B]Cornea Center for Clinical Excellence, [1]Illinois College of Optometry, Chicago, IL; [2]Ophthalmology, Rush University Medical Center, Chicago, IL.
Purpose: During dynamic focusing, the shape, as well as the internal ultrastructure of the lens is changed. Our lab is investigating changes in the ultrastructure, specifically at the sutures, of the lens during accommodation. We have hypothesized that unique structural features and organization of fiber cells enables them to interface at the sutures resulting in a change in surface curvature of the lens, allowing near focus to occur. We are currently using slit lamp and sequential ray tracing analysis of the patterns associated with the sutures to provide additional insight into the importance of the ultrastructure of the lens in the accommodative process. To further support our hypothesis, we are investigating changes in higher order aberrations in various states of accommodation. Preliminary observations are being reported here.
Methods: Wavefront analysis and accommodative response using the iTrace (Tracey Technology, Houston, TX) was collected on normal subjects, between the ages of 20-35 (n=26). Data were collected from the right eye as the subject viewed a lighted distance, then near target (40 cm) with their normal correction using their left eye. Accommodation was stimulated using minus lenses in 2.5 D increments until the subject could no longer clearly view the target. Data were preliminarily analyzed using SPSS to measure correlations between zernike polynomials for the internal optics (mostly lens) of the eye and accommodative response. We focused mainly on those indicative of suture patterns (trefoil, tetrafoil, pentafoil, hexafoil, and heptafoil). Correlation coefficients and p values are presented.
Results: When analyzed as raw data (n=74), there was a correlation between accommodative response and trefoil (C6 : 0.234, p=0.045), tetrafoil (C10 : -0.234, p=0.045 and C22 : 0.232, p=.047) and pentafoil (C15 : -0.226, p=0.050). From these preliminary results, further analysis of combined Zernike polynomials is needed. In addition, higher level of accommodation are needed, so if using this type of system, the impact of convergence on the aberrations needs to be reduced.
Conclusions: There are changes in higher order aberrations that may be indicative of a role for the lens fiber interactions at the sutures during accommodation. Further research investigating these patterns during growth and aging, as well as during accommodation is needed. A potential use of these patterns in detecting early problems with vision may be useful in a clinical setting.
Commercial Relationships: Rebecca K. Zoltoski, None; **Jennifer Harthan**, None; **Kyle Klute**, None; **Marc Landes**, None; **Jer R. Kuszak**, None
Support: NIH Grant EY021015-01 and ICO RRC

Program Number: 835 **Poster Board Number:** D983
Presentation Time: 11:15 AM - 1:00 PM
Evaluation Of The Grand Seiko WAM And Apple Micro-display For The Study Of Accommodative Response To Near Stimuli
Tina K. Green, Joseph M. Miller, Howard P. Apple, Erin M. Harvey, Dawn H. Messer, J. Daniel Twelker. Ophthalmology and Vision Science, University of Arizona, Tucson, AZ.
Purpose: To determine the feasibility of using the Grand Seiko WAM-5500 binocular open-field autorefractor (GSWAM) to evaluate the accommodative response of children while they read near text.
Methods: The GSWAM was modified to include a bridge-of-the-nose rest instead of a chin rest to allow them to speak with minimal head movement. An iPod touch (Apple, Inc, 326 pixels per inch) was used to present three stimulus displays. Each consisted of 5 logMAR lines of five letters and each display used stimuli of a different size (0.1, 0.4, and 0.7 logMAR at 40cm). Twenty-five 6-12th grade students from schools at which the majority of students were members of a Native American Tribe (Tohono O'odham) with a high prevalence of astigmatism viewed each stimulus display through the GSWAM for a 10 second measurement interval, and were asked to read the letters aloud while the GSWAM was in continuous recording mode, recording spherical equivalent (SE) data at a maximum rate of 5 measurements/sec. SE measurements of approximately -2.50 D would indicate that subjects were accommodating to the 40cm target. Data from the middle 8 seconds of each 10 second measurement interval were included. For each interval, mean SE and standard deviation (SD) of SE were calculated.
Results: At least 8 measurements per 8 second measurement interval were obtained for 96%, 92%, and 92% of subjects in the 0.1, 0.4, and 0.7 logMAR conditions. The table below summarizes the grand mean of SE means, the grand mean of SD means, and the mean number of SE measurements. There were no significant effects of stimulus size on SE or number of measurements. Mean SD was greater for the 0.1 logMAR stimuli ($p < 0.05$).
Conclusions: A rate of at least 1 measurement/sec was achieved for over 90% of subjects. On average, subjects were accommodating to the near target as predicted. Variability (SD) was greater for the smallest stimulus, which may indicate that subjects' were varying accommodation to try to resolve the small stimuli. This experimental setup is promising for use in evaluation of accommodative patterns over time during visual task performance.

Measure	Stimulus Size	Mean	Std. Deviation	Minimum	Maximum
Mean Spherical Equivalent (SE)	0.1	-2.60	1.42	-6.37	1.33
	0.4	-2.63	1.53	-6.10	0.34
	0.7	-2.75	1.24	-6.50	-1.17
Mean Standard Deviation of SE Measurements	0.1	0.77	0.57	0.10	1.86
	0.4	0.53	0.50	0.09	2.34
	0.7	0.59	0.55	0.10	2.08
Mean number of SE Measurements	0.1	27.88	10.25	5	40
	0.4	28.08	12.08	1	40
	0.7	26.92	12.55	1	40

Commercial Relationships: Tina K. Green, None; **Joseph M. Miller**, None; **Howard P. Apple**, None; **Erin M. Harvey**, None; **Dawn H. Messer**, None; **J. Daniel Twelker**, None
Support: NIH Grant EY 13153 and Research to Prevent Blindness

Program Number: 836 **Poster Board Number:** D984
Presentation Time: 11:15 AM - 1:00 PM
Accommodative Response Measurements Based On Double Pass Images
Mikel Aldaba, Meritxel Vilaseca, Montserrat Arjona, Jaume Pujol. CD6, Univ Politecnica de Catalunya, Terrassa, Spain.
Purpose: To measure accommodative response (AR) by means of a double-pass (DP) system looking for the best retinal image for different accommodative stimulations. Results from the DP system were compared to those obtained with a Hartmann Shack (HS) sensor, and the AR in the first steps of stimulation was also analyzed.
Methods: AR was measured with an open field DP system developed in our laboratory. DP images contain complete information on the aberrations and scattering of the eye (Díaz-Doutón et al, IOVS 2006). For each object position an axial scanning was performed in order to find the best retinal image; from the vergence of this image we calculated the AR of the patient. Simultaneously, HS images were recorded, and AR was calculated based on the retinal image quality and the defocus from the Zernike terms. AR was calculated in order to have no accommodative error at 1D stimulation.
Ten young healthy adults were enrolled in the study with a mean ± SD in age of 28.75 ± 2.12 years (range: 25 to 31 years), subjective spherical refraction of +0.15 ± 0.56 D (+0.75 to -0.25 D), subjective astigmatic refraction of +0.15 ± 0.56 D (0 to -0.5 D), best corrected visual acuity of 1.17 ± 0.07 (1.0 to 1.25). Patients were corrected according to their subjective refraction, had monocular vision and were instructed to focus on a fixation test during measurements. Accommodation was

stimulated from 0 to 5 D using a push-up method, in steps of 0.5 D from 0 to 2 D, and steps of 1D from 2 to 5 D.
Results: When measuring with the DP system, accurate AR were generally obtained: 0.39 ± 0.29 D for 0 D stimulation, 1 ± 0 D for 1 D, 1.87 ± 0.37 D for 2 D, 2.85 ± 0.51 D for 3 D, 3.79 ± 0.45 D for 4 D, and 4.68 ± 0.53 D for 5 D. AR measurements assessed using HS data and based on the best retinal image were in good agreement with the former DP ones, with a mean difference of 0.11 D. On the other hand, defocus based measurements highlighted a higher mean difference: 0.28 D.
In the first steps of stimulation (specifically from 0 to 2 D) an accurate AR was measured, although a slightly reduced accommodative range of 1.48 D was found. This could probably be attributed to the lead of accommodation in far vision.
Conclusions: We measured AR from the best retinal image obtained with a DP system. When comparing the results with HS measurements, we found higher differences when this last was based on defocus, and not on the retinal image quality. The method developed is simple and robust and therefore it could be implemented in medical instruments for clinically assessing accommodation.
Commercial Relationships: Mikel Aldaba, None; **Meritxel Vilaseca**, None; **Montserrat Arjona**, None; **Jaume Pujol**, None
Support: Ministerio de Educación y Ciencia", Spain (grant nº DPI2008-06455-C02-01); "Ministerio de Asuntos Exteriores y de Cooperación, Spain (grant nº D/017822/08)

Program Number: 837 **Poster Board Number:** D985
Presentation Time: 11:15 AM - 1:00 PM
What Is The Amplitude Of Accommodation Of An Aberrated Eye?
Norberto Lopez-Gil[1A], Vicente Fernandez-Sanchez[1B], Larry N. Thibos[2A], Arthur Bradley[2A], Jesson Martin[2B]. [A]Physics, [B]Ciencias de la Vision, [1]Universidad de Murcia, Murcia, Spain; [A]Optometry, [B]School of Optometry, [2]Indiana University, Bloomington, IN.
Purpose: Amplitude of accommodation (AA) is the dioptric distance between the far and near point which, although uniquely defined in an aberration-free eye, can vary with definition of best focus in the presence of spherical aberration (SA) which changes during accommodation. We study how changes in ocular SA that occur during accommodation affect objective measures of AA.
Methods: Based on published anatomical data we perform a theoretical ray-tracing study of accommodation obtained when using only the central pupil optics (paraxial refraction, not affected by SA) or the whole pupil, (e.g. minimum wavefront variance or which is affected by SA). The results are compared with AA measures obtained objectively (by wavefront sensing) and subjectively (subjects were instructed maintain "clear focus" of a target whose optical vergence was adjusted using a custom made Badal optometer). 82 subjects (23.5±2.6 years) were tested in a dioptric range that exceeded their AA.
Results: For a 4.5 mm pupil, theoretical modeling shows that the lens shape changes responsible for the change in sign of SA during accommodation produce a significant reduction in the AA defined by a minimum rms refraction compared to a paraxial refraction. On average, experimental data reveal a measured objective AA of 1.48 D less than subjective AA. This large apparent error in accommodation includes a combination of lower than ideal accommodation by the subject because of depth of focus (on the first pass) and a lower objective measure of accommodation by an aberrometer measuring the minimum rms refraction (on the second pass). Conversely, if accommodation was designed to maintain minimum rms focus, and the objective instrument measured paraxial focus, objective measures of accommodation could exceed the stimulus demand.
Conclusions: Because of the change of SA during accommodation, objective measures of AA could be significantly different from subjective measures if the instrument's pupil weighting does not mirror that of the human accommodative control system.
Commercial Relationships: Norberto Lopez-Gil, None; **Vicente Fernandez-Sanchez**, None; **Larry N. Thibos**, None; **Arthur Bradley**, None; **Jesson Martin**, None
Support: Fundación SENECA, Región de Murcia, Grant 05832/PI/07 to NLG. NIH Grant # R01-EY05109 to LT.

Program Number: 838 **Poster Board Number:** D986
Presentation Time: 11:15 AM - 1:00 PM
Accommodative Lag Changes in Uncorrected Astigmatic and Non-Astigmatic Students While Attempting to Read Small and Large Letters
Howard P. Apple[1A], Joseph M. Miller[1A,1B], Erin M. Harvey[1A], Tina K. Green[1A], Dawn H. Messer[1A], J.Daniel Twelker[1A]. [A]Ophthalmology and Vision Science, [B]College of Optical Sciences and College of Public Health, [1]University of Arizona, Tucson, AZ.
Purpose: To compare accommodative lag in uncorrected non-astigmatic and astigmatic students while binocularly viewing large (20/100) and small (20/25) letters at 40 cm.
Methods: The Grand Seiko WAM-5500 was modified to use a bridge-of-the-nose rest, allowing subjects to speak while reading letters displayed on an iPod Touch (Apple Inc) microdisplay. Subjects were 15 6th - 12th grade students from schools where the majority of the children are members of a Native American Tribe (Tohono O'odham) with a high prevalence of astigmatism. Cycloplegic autorefraction (Retinomax K-Plus, Nikon, now Right Mfg) was performed. We excluded myopic subjects whose SEQ was >-2.50D The WAM, a binocular full-field viewing monocular autorefractor, was used in continuous recording mode at 5 samples per second. Subjects read aloud from the display of 5 lines of 5 letters having Snellen equivalent sizes of 20/25, 20/50, and 20/100. All 15 could read the 20/100 display, while 7 could read the 20/25 display.
Results: Eight students had <1 D of refractive astigmatism, and 7 had > 1D. Students able to read the 20/25 line (R25+) had mean (sd) of 0.43 (0.49) D astigmatism (min 0D, max 1.25 D), while those unable to read the 20/25 line (R25-) had 2.5 (1.70) D astigmatism (min 0.75D max 5D) (p=0.0086). SEQ refraction did not differ between the groups (R25+ -0.71 (1.41) D, R25- -0.199 (1.71) D (p=0.51)). Accommodative Lag (AL), defined as the difference between the demand placed by the target distance (2.5D) and SEQ measured by the autorefractor, was measured and pooled across subjects with n=440 for AL determinations while reading 20/25 stimuli, and n=431 while reading 20/100. Those who could read 20/25 (R25+) had 0.36 (1.09) D lag, while R25- had -0.024 (0.94) D while viewing the 20/25 letters (p=0.0001). AL observed while reading 20/100 letters shifted for both groups, with R25+ having 0.170 (0.81) D, and R25- 0.27 (0.88) D of AL (p=0.195).
Conclusions: Binocularly viewing of letters too small to read causes focus to shift closer to the spherical equivalent refraction in predominantly astigmatic subjects. Reading larger letters results in positive lag in both groups of subjects.
Commercial Relationships: Howard P. Apple, None; **Joseph M. Miller**, None; **Erin M. Harvey**, None; **Tina K. Green**, None; **Dawn H. Messer**, None; **J.Daniel Twelker**, None
Support: NIH EY13153(EMH),NIH EY08893(JDT), RPB Walter E and Lily Disney Award (JMM)

Program Number: 839 **Poster Board Number:** D987
Presentation Time: 11:15 AM - 1:00 PM
Treatment Of Asthenopia In Children With And/or Without Neck-shoulder Muscular Pain
Jan Johansson, Tony Pansell, Saber Abdi. St Erik Eye Hospital, Karolinska Institutet, Stockholm, Sweden.
Purpose: To evaluate the association between asthenopia and neck-shoulder muscular pain associated to near work and computer use in children and young adults.
Methods: 65 children and adolescents (7-18 years of age) had been referred for optometric/orthoptic examination by school doctors, school nurses and physiotherapists due to asthenopia and/or neck-shoulder pain. Group 1: with neck-shoulder pain but without asthenopia. Group 2: with neck-shoulder pain and asthenopia. Group 3: with asthenopia but without neck-shoulder pain. Group 4: without neck-shoulder pain and without asthenopia. A complete orthoptical and ophthalmological examination was done for all subjects. All four groups underwent an eight week treatment. Group 2 and 3 received optometric/orthoptic treatment of their asthenopia. Group 1 and 4 received placebo treatment, i.e. a pair of plano or +0.25D glasses. After the 8-week treatment period all subjects were re-examined.
Results: Group 1 (neck-shoulder pain only) have a statistically significant reduced accommodative amplitude compared to the expected level according to Hofstetters formula (18.5-0.3age). In terms of accommodative amplitude there was a significant difference between group 1 and 4 ($p<0.05$), between group 2 and 4 ($p<0.001$) and between group 3 and 4 ($p<0.001$). At the comparison of accommodative amplitude for group 1 and 4 to the expected accommodative amplitude according to Hofstetters formula it was found that group 1 differed significantly ($p<0.0001$) while group 4 did not differ significantly ($p=0.8311$). The difference in subjective symptoms (VAS) before and after treatment for group 1 was not significant ($p=0.3125$). For group 2 and 3 the difference in VAS before and after was significant ($p<0.0001$). For group 4 the difference was not significant. At a comparison of the actual reduction in VAS measure between group 2 and 3 there was no significant difference to be found ($p=0.1616$).
Conclusions: The results of this study show that there is a statistically significant reduction in symptoms after the treatment of asthenopia. Furthermore the results for group 2 (asthenopia and neck-shoulder) strongly suggests the occurrence of functional cross-talk between oculomotor- and musculoskeletal system.
Commercial Relationships: Jan Johansson, None; **Tony Pansell**, None; **Saber Abdi**, None
Support: None

Program Number: 840 **Poster Board Number:** D988
Presentation Time: 11:15 AM - 1:00 PM
Is A Deep Foveal Pit A Specialized Wavefront Vergence Detector For Accommodation?
Clarissa Kum[1], Philip B. Kruger[1], Mitchell W. Dul[1], Lawrence R. Stark[2]. [1]SUNY State College of Optometry, New York, NY; [2]Southern California College of Optometry, Fullerton, CA.
Purpose: To determine whether variation in foveal pit depth among observers explains wide inter-subject variation in ocular accommodation to wavefront vergence.
Methods: Foveal pit images were obtained from 20 normal observers (ages 21-27 yrs) using the Cirrus Spectral Domain HD-OCT set to a scan setting of 512x128

macular cube. The pit depths were measured using the digital calipers provided in analysis mode on the Cirrus Spectral Domain HD-OCT.
Accommodation was recorded at a frequency of 100 Hz with observers viewing a high contrast Maltese cross in a Badal optical system through a 3 mm artificial pupil, while wavefront vergence (Zernike defocus) changed sinusoidally (1-3 D) at 0.2Hz. Six trials were run in broadband white light (3000K; 20 cd/m^2) and six in monochromatic light (550 nm: 12nm bandwidth; 20 cd/m^2) to eliminate chromatic aberration. Each trial lasted 40.96 seconds.
Fast Fourier transform was used to extract the dynamic gains and temporal phase-lags at the stimulus frequency of 0.2Hz. Mean gains and temporal phase-lags were calculated for monochromatic and chromatic conditions separately.
Results: Foveal pit depths ranged from 99 to 209 microns and accommodation gain varied widely between 0.04 and 0.66.
Linear regression showed no significant correlation between foveal pit depth and accommodation to wavefront vergence for this group of 20 subjects (r^2=0.112).
Conclusions: Foveal pit depth does not explain the wide inter-subject variation in dynamic accommodation gain to changing wavefront vergence.
Commercial Relationships: Clarissa Kum, None; **Philip B. Kruger**, None; **Mitchell W. Dul**, None; **Lawrence R. Stark**, None
Support: NEI T35 Summer Research Training Grant

Program Number: 841 **Poster Board Number:** D989
Presentation Time: 11:15 AM - 1:00 PM
A Conversion Equation to Predict Objective Accommodative Amplitude from the Subjective Push-Up Test
Heather A. Anderson[1A], Karla K. Stuebing[1B]. [A]College of Optometry, [B]TIMES Institute, [1]University of Houston, Houston, TX.
Purpose: The standard clinical technique for measurement of accommodative amplitude is the subjective push up test. Although simple to perform, this test is not a true measure of accommodation and largely overestimates amplitude. The purpose of this study is to develop a conversion equation to predict objective amplitude from subjective push up measurements.
Methods: Monocular accommodative amplitudes were measured on the right eye of 227 subjects aged 3 to 64 years using both an objective technique and the subjective push-up test. For objective measurements, subjects were instructed to focus on a 20/40 letter on the near rod of the Grand Seiko autorefractor at 7 positions increasing from 2.5 to 8D, and then 6 additional positions from 10.5 to 30D as the letter was placed on a near rod attached to the forehead rest of the autorefractor. Repeated measurements of refraction were taken for each demand and the stimulus-response function plotted. Maximum amplitude was defined as the point at which the function peaked or plateaued. For subjective measurements, the same target was moved along an accommodative rule at increasing proximity until the subject reported first blur. Three repeated measurements were averaged to determine the maximum amplitude.
Results: Multiple regression analysis was used to evaluate the correlation between objective amplitude, subjective amplitude, and age. Both subjective amplitude and age were significant predictors of objective amplitude ($p < 0.001$) and, when combined, accounted for a large portion of the variance in objective measurements across subjects ($p < 0.001$, $R^2 = 0.805$). From this analysis, predicted objective amplitude was defined as 8.75 - (0.15*age) + (0.08*subjective amplitude). When comparing predicted objective amplitude versus measured objective amplitude for each subject, the formula accurately predicted the measured objective amplitude within ±2D for 90% of all subjects.
Conclusions: This data proposes a conversion equation which may be utilized clinically to convert subjective push-up amplitude measurements to objective amplitudes based upon patient age and push-up response. Future studies are needed on additional subject populations to further test the accuracy of the equation before it can be recommended for widespread use.
Commercial Relationships: Heather A. Anderson, None; **Karla K. Stuebing**, None
Support: Fight for Sight Grant in Aid

Program Number: 842 **Poster Board Number:** D990
Presentation Time: 11:15 AM - 1:00 PM
Effect of General Anesthesia on Accommodation in Children
Inna Marcus, Daniel J. Salchow. Ophthalmology and Visual Science, Yale University School of Medicine, New Haven, CT.
Purpose: To determine the effect of general anesthesia (GA) on accommodation in children.
Methods: Subjects underwent cycloplegic refraction during an office visit 30-40 minutes after administration of cyclopentolate 1% twice, several minutes apart. For a planned procedure, GA was administered and pupils were dilated with phenyelphrine 2.5% twice, several minutes apart. After the non-study eye underwent the planned procedure, the study eye was refracted using the same method as in the office.
Results: Measurements under GA were obtained in 8 of the 9 subjects. Average age was 7.44 years (SD 4.89; range 1.83 to 18 years). Average difference in sphere was -0.44D (95% confidence interval, CI -1.24D to +0.36D). Average difference in cylinder was -0.19D (95% CI -0.97D to +0.60D). Average difference in axis was -0.13° (95% CI -3.25° to +3°). Average difference in spherical equivalent was -0.78D (95% CI -1.44D to +0.12D). The measurement under GA was within 0.25D of the office measurement in 5 of 8 subjects for sphere, 6 of 8 subjects for cylinder and 3 of 8 subjects for spherical equivalent.
Conclusions: Although it would be helpful to know whether GA relaxes accommodation - i.e. whether it induces cycloplegia - there is a paucity of studies evaluating the effect of GA on accommodation. Earlier studies, using GA protocols not practiced anymore, found GA to induce a significant myopic shift in some patients. Our study shows that, using current protocols, GA induces cyloplegia in most children.
Commercial Relationships: Inna Marcus, None; **Daniel J. Salchow**, None
Support: None

Program Number: 843 **Poster Board Number:** D991
Presentation Time: 11:15 AM - 1:00 PM
Accommodation and Vergence Adaptation in Myopic Children
William R. Bobier, Vidhyapriya Sreenivasan, Elizabeth L. Irving. School of Optometry, University of Waterloo, Waterloo, ON, Canada.
Purpose: To compare the adaptive properties of accommodation and vergence in early onset myopes with emmetropic controls. Empirical measures had been taken over a series of experiments where children viewed a (cartoon clip) target at 33cm through either +/- 2D near adds or a 10 pd base out prism for 20 minutes.
Methods: Data were selected from two of our previous studies, but subjects were balanced to show normal near phorias for the plus add study and normal tonic vergence levels for the prism study. This controlled for previously found effects resulting from phoria magnitude and direction. The following designs had been used.Children were between the ages of 7 - 14 years. 11 emmetropes and 10 myopes viewed through near adds for 20 min. Then 14 emmetropes and 14 myopes viewed a DOG target through 10pd base out prism for 20 min. For both studies accommodation was measured dynamically at 25Hz (Power Refractor, Multichannel systems). Responses were averaged over 5 sec and sampled at regular intervals over 20 minutes. Phorias and tonic vergence were measured with a Thorington technique . Tonic accommodation was measured at 4M using a DOG target (0.5cpd) before and after viewing which defined accommodative adaptation (AA). Vergence adaptation (VA) was determined by the pattern of recovery of the initial phoria through the near adds or the 10 pd prism over the 20 min viewing period. Response AC/A and CA/C measures were taken prior to testing.
Results: Statistical significance was set at $p<0.05$. Myopes showed significantly greater AA viewing through negative adds (-0.56D±0.08 vs -0.30±0.03) and during prism viewing (-0.33D±0.1 vs 0.02D±0.16). No change in AA was found with plus add viewing. The degree of phoria recovery (VA) was significantly reduced in myopes (54.7%±3.8 vs. 81.8%±2.2) for the plus add but not for the minus add. A similar pattern of significantly reduced VA in myopes was found following prism viewing (57%±2.5 vs. 70%±2.4). The response AC/A was significantly elevated in myopes (6.17pd/D±0.46 vs 4.26pd/D±0.3) but no significant difference was found between the CA/C measures.
Conclusions: Myopes show greater AA and reduced VA compared to emmetropes when accommodation and fusional convergence demands are increased. The AC/A and CA/C findings are not readily explained from the differing adaptation profiles.
Commercial Relationships: William R. Bobier, None; **Vidhyapriya Sreenivasan**, None; **Elizabeth L. Irving**, None
Support: NSERC, Canada, CFI, CRC, AOF

Program Number: 844 **Poster Board Number:** D992
Presentation Time: 11:15 AM - 1:00 PM
Accommodation Response Thresholds And Peripheral Refraction In Emmetropes And Myopes
Lorraine A. Duffy, Mhairi M. Day, Dirk Seidel, Lyle S. Gray, Niall C. Strang. Vision Sciences, Glasgow Caledonian University, Glasgow, United Kingdom.
Purpose: The accommodation response threshold (ART) describes the required change in stimulus vergence to produce an accommodation response. The aim of this study was to measure ART for axial and peripheral retinal stimuli and relate this to axial and peripheral refraction measures in emmetropes (EMMs) and myopes (MYOs).
Methods: 5 EMMs and 5 MYOs participated with informed consent. ARTs were measured in the right eye while subjects viewed circular annuli containing a 4cpd vertical sine wave grating in a +5D Badal system. Targets were presented at the open-loop accommodation level and MYOs axial refractions were fully corrected using disposable soft contact lenses. Targets subtended 1deg and achieved retinal stimulation at 0, 4 and 8deg and target vergence varied sinusoidally with a frequency of 0.5Hz. For each trial, 10 continuous measures of accommodation of 16s duration were recorded and power spectra were obtained from fast Fourier transform analysis. The 10 spectra for each stimulus condition were averaged and the power for bins at 0.43-0.55Hz was summed. ART was defined as the stimulus amplitude at which a significant increase in power occured compared to a stationary target (0Hz). Peripheral retinal defocus was calculated based on refraction measures obtained using a Grand Seiko FR-5000 autorefractor at the open-loop accommodation level. Pupils were dilated with phenylephrine 10% and the instrument was rotated to obtain measures at 0, 5 and 10deg nasal and temporal along the horizontal meridian.
Results: Mean±SD central ART (0.42±0.08D) was similar in both refractive

groups (p>0.05) . ARTs increased linearly with eccentricity in EMMs (0.06D/deg, R^2=0.99) and MYOs (0.11D/deg, R^2=0.99). MYOs showed significantly higher ARTs than EMMs at 4 and 8deg (p<0.05). Peripheral defocus did not change significantly up to 10deg retinal eccentricity and was similar in MYOs and EMMs (p>0.05).
Conclusions: Peripheral ARTs in MYOs are not affected by the peripheral refraction. This would suggest that the cause of higher peripheral ARTs in MYOs is neural in nature. The findings suggest that the accommodation control mechanism in myopes integrates information over an extended retinal area which could explain increased accommodative microfluctuations previously reported in this refractive group.
Commercial Relationships: Lorraine A. Duffy, None; **Mhairi M. Day**, None; **Dirk Seidel**, None; **Lyle S. Gray**, None; **Niall C. Strang**, None
Support: None

Program Number: 845 **Poster Board Number:** D993
Presentation Time: 11:15 AM - 1:00 PM
Optical Properties and Accommodation in the Guinea Pig Eye
Marsha L. Kisilak[1A], Kaitlin Bunghardt[1A], Melanie C. Campbell[1A,2], Elizabeth L. Irving[1B], Sally A. McFadden, V[3]. [A]Physics & Astronomy/Sch of Optometry, [B]School of Optometry, [1]University of Waterloo, Waterloo, ON, Canada; [2]Guelph-Waterloo Physics Institute, Waterloo, ON, Canada; [3]Faculty of Science and IT, University of Newcastle, Callaghan, Australia.
Purpose: Generally, the guinea pig eye shows emmetropization and accommodation and is a model of myopia. Some animals have been reported to be spontaneously myopic and lack accommodation. We studied the retinal image quality in the guinea pig eye as a function of any accommodation.
Methods: Three male guinea pigs aged 5.5 weeks were acquired from a Canadian pet supplier. Retinoscopy and Hartmann-Shack (H-S) measurements were attempted in each awake animal with natural pupils and in two animals after cycloplegia (1% cyclopentolate). Keratometry was performed on all eyes. Eye length was measured in one animal. H-S measurements were analyzed for refractive errors and higher order aberrations (HOA) and their co-dependence was assessed. Values of astigmatism and HOA's are reported for the first time.
Results: Noncycloplegic retinoscopy gave variable refractions across and within eyes, from hyperopic to myopic. One eye with 6D of myopia by retinoscopy prior to cycloplegia became emmetropic after cycloplegia. For many of the H-S frames, spots could not be analyzed due to poor tear film and optical quality issues. Average H-S refractions varied from -1.2D to +3.1 D in different eyes. Under cycloplegia, the quality of the H-S patterns worsened. Refraction, eye length and keratometry values were consistent with published values. Cylinder values ranged between 1.5 and 2 D. HOA's could be analyzed over pupil sizes up to 3 mm diameter, smaller than the full pupil, giving root mean square values of 0.08 microns. Spherical aberration (SA) was highly variable, even across frames within an eye. SA was increasingly negative with increasingly negative mean ocular refraction (MOR), significant when data were combined across all eyes (p<0.0001). HOA also depended significantly on MOR in some eyes and across all eyes with a minimum close to emmetropia.
Conclusions: The optical quality of these guinea pig eyes was poorer than chick eyes (a diurnal species) and more similar to our previously reported results in rat eyes, another non-diurnal species. Optical quality worsened with tear film degradation and cycloplegia. Unlike other rodents, these animals appear to accommodate. The dependence of SA on MOR also suggests varying accommodation during H-S measurements, similar to that seen in humans with accommodation. As in other species, SA, astigmatism and accommodation could provide signals to emmetropization. Although accommodation appears to increase the variability of HOA's, cycloplegia impairs optical quality.
Commercial Relationships: Marsha L. Kisilak, None; **Kaitlin Bunghardt**, None; **Melanie C. Campbell**, None; **Elizabeth L. Irving**, None; **Sally A. McFadden, V**, None
Support: NSERC Canada, CFI, CRC, PREA

Program Number: 846 **Poster Board Number:** D994
Presentation Time: 11:15 AM - 1:00 PM
Positional Stability Of A Phakic Anterior-chamber Angle-supported Intraocular Lens During Accommodation
Thomas Kohnen, Oliver K. Klaproth, Jörg Rehrmann, Martin Baumeister. Ophthalmology, Goethe University, Frankfurt am Main, Germany.
Purpose: Evaluation of anterior-posterior position changes of a phakic anterior-chamber angle-supported intraocular lens (PIOL) (Cachet, Alcon) during accommodation.
Methods: Bilateral implantation of the PIOL in 13 patients (8 male, 8 female, 36,±35,36 years). Assesment of defocus curves (1D steps from -7D to +1D) has been performed at the ETDRS Charts (Vectorvision) preoperatively and one month postoperatively. At the same time points measurement of pupil diameter (PD), anterior chamber depths (ACD) and (one months postoperative) intraocular distances of the PIOL to the corneal endothelium (M1) and the natural lens (M2) has been performed using optical coherence tomography (Visavte OCT, Zeiss) with the respective accommodative stimuli. Statistical analysis was performed using Shapiro-Wilk testing, one-sample t-test and Wilcoxon's signed ranks test, the overall significance was set to p=0.05.
Results: ACD and PD did not change significantly from pre- to postoperative measurements for any accommodative stimulus. A significant change in postoperative intraocular distances was shown with the one-way t-test compared to 0D acommodative stimulus reference value (REF) for M1 at stimuli of -7D and -6D (REF_{M1}=2.15mm, $\Delta_{M1,-7}$=-0.09mm und $\Delta_{M1,-6}$=-0.08mm) as well as for M2 at stimuli of -5D and -4D (REFM2=0.79mm, $\Delta_{M2,-5} = \Delta_{M2,-4}$=-0.09mm). A trend towards slight foward movement of the IOL was seen. The defocus curve showed a significant improvement (Wilcoxon's signed ranks test) of visual acuity from pre- to postoperative status for accommodative stimuli from -4D to +1D. Best corrected visual acuity (BCVA) was -0.01±0.09 logMAR preoperative and 0.07±0.07 logMAR postoperative.
Conclusions: The PIOL showed a slight tendeny towards forward movement during accommodation, however, this was mostly not significant nor clinically relevant. Patients gained approximately one line of BCVA with no decrease in accommodative range.
Commercial Relationships: Thomas Kohnen, Alcon (F, R); **Oliver K. Klaproth**, Alcon (F, R); **Jörg Rehrmann**, None; **Martin Baumeister**, None
Support: None

Program Number: 847 **Poster Board Number:** D995
Presentation Time: 11:15 AM - 1:00 PM
Reading Performance After Implantation Of A Small Aperture Corneal Inlay For The Surgical Correction Of Presbyopia: Two-Year Follow-Up Of 32 Patients
Alois K. Dexl, Theresa Rückl, Orang Seyeddain, Wolfgang Riha, Melchior Hohensinn, Wolfgang Hitzl, Günther Grabner. University Eye Clinic, Paracelsus Medical University, Salzburg, Austria.
Purpose: To evaluate the effectiveness of the KAMRA™ intracorneal inlay - as it effects changes in the parameters of reading performance over a follow-up period of 2 years.
Methods: This prospective, non-randomized, non-comparative study comprised 32 naturally emmetropic, presbyopic patients. Bilateral reading acuity, reading distance, reading speed and smallest log-scaled sentence, have been evaluated in a standardized testing procedure using the Salzburg Reading Desk (SRD). Minimal postoperative follow-up was 24 months.
Results: The SRD results showed a significant improvement in each of the parameters tested. After a mean follow up period of 24.2±0.8 months the mean reading distance changed from pre-op 48.1±5.5cm to 38.9±6.3 cm (p <0.001), the reading acuity "at best distance" improved from 0.3±0.14 logRAD to 0.24±0.11 logRAD (p <0.001), and the reading speed increased from 142±13 wpm to 149±17 wpm (p =0.029). One patient lost one line, and in one patient there was no change at all, where as all other patients (30/32) improved up to 6 log-scaled lines, with a mean improvement of 2.7±1.6 lines.
Conclusions: The KAMRA™ intracorneal inlay causes an improvement in all tested parameters of reading performance in emmetropic, presbyopic patients, by increasing the depth of field, and it seems to be an effective treatment for presbyopia, over a minimum follow-up period of two years.
Commercial Relationships: Alois K. Dexl, Salzburg Reading Desk patent assignee (P); **Theresa Rückl**, None; **Orang Seyeddain**, None; **Wolfgang Riha**, AcuFocus Inc. (E); **Melchior Hohensinn**, None; **Wolfgang Hitzl**, None; **Günther Grabner**, AcuFocus Inc. (R), Salzburg Reading Desk patent assignee (P)
Support: Research Project supported by the "Fuchs Foundation for the Promotion of Ophthalmology" and "Adele-Rabensteiner-Foundation" (Austrian Ophthalmological Society)
Clinical Trial: http://www.clinicaltrials.gov, NCT00806052

Program Number: 848 **Poster Board Number:** D996
Presentation Time: 11:15 AM - 1:00 PM
Effect Of Scleral Buckling (SB) Procedure On Accommodation
Jared P. McDonald[1A], Mary Ann A. Croft[1B], Paul L. Kaufman[2]. [A]Ophthal & Vis Sci, [B]Ophthal & Vis Sciences, [1]Univ of Wisconsin-Madison, Madison, WI; [2]Ophthal & Visual Science, Univ of Wisconsin Sch of Med & Public Hlth, Madison, WI.
Purpose: A previous report indicated that a SB procedure may induce myopia (ARVO 2002). Our goal was to determine whether accommodation was increased in human patients following a SB procedure
Methods: Eight subjects, ranging in age from 22 to 64 years, were screened post SB surgery. Accommodation was measured in one or both eyes of each subject. Accommodation was induced pharmacologically by giving 2 drops topically of 4% pilocarpine HCl (PILO) with a 10 min interval. Refraction (Hartinger; HCR) was measured before and after PILO at 15 min intervals. Intraocular distances (A- Scan; Model A-5500), and ultrasound biomicroscopy images (Humphrey Model 840) of the anterior and posterior segments were gathered before and after maximum accommodation was achieved. Accommodation was calculated as the difference between pre-PILO and post-PILO refraction.
Results: The SB eye of two subjects accommodated 4-5 diopters above the contralateral control eye (CC) and exceeded values in Duane's curve for their ages of 38 and 53 years. One subject had a lower accommodative amplitude (1.75 diopters) in the SB eye compared to the CC eye. The five remaining subjects

showed no significant increase/decrease in accommodation amplitudes in the SB eye verses their CC eye. The differences in intraocular distances between SB and CC eyes (SB-CC) in all eight subjects averaged together showed that the anterior chamber was deeper (by 0.11±0.01 [s.e.m.] mm), the lens thicker (by 0.15±0.11mm), and the globe length longer (by 0.45±0.22mm), but the differences were not statistically significant. However, further analyses are proceeding to compare pre SB accommodative amplitudes obtained clinically in the ipsilateral eye, surgical techniques and intraocular distances.
Conclusions: The varied accommodative amplitude results following the SB surgical procedure to correct a retinal detachment in these 8 subjects may be due to differences in SB surgical techniques used and changes in intraocular distances.
Commercial Relationships: Jared P. McDonald, None; **Mary Ann A. Croft**, None; **Paul L. Kaufman**, None
Support: None

Program Number: 849 **Poster Board Number:** D997
Presentation Time: 11:15 AM - 1:00 PM
Direct Measurement Of Lens Tissue Stiffness Reduction Induced By Femtosecond Laser Treatment
Robert Kammel[1], Stephanie Bühren[1], Roland Ackermann[1], Stefan Nolte[1,2], Andreas Tünnermann[1,2]. [1]Institute of Applied Physics, Friedrich Schiller University, Jena, Germany; [2]Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany.
Purpose: To renew flexibility of the aged lens as a treatment for presbyopia, decrease of lens stiffness was investigated for different spot patterns induced by fs-laser treatment of the crystalline lens.
Methods: To measure the resistibility of porcine lenses before and after fs-laser treatment extracted lenses were placed on a lens holder on an analytical balance within 12 hours post-mortem. Lenses were pressed against a contact glass with less than 20 mN creating a low deformation. Forces transferred by the elastic lens tissue were measured and recorded automatically. After reaching a pre-assigned load, patterns of up to 2 million separate disrupted spots were applied using a fs-laser system attached to a 3D-galvano-scanner. Pulse energy was kept slightly above the threshold of laser induced optical breakdown to avoid the formation of cavitation bubbles. Measurements for different laser patterns and numbers of applied spots could be realized.
Results: The presented setup allows direct measurement of reduced lens stiffness within the same lens avoiding complex statistical comparison of laser treated and untreated lenses. After applying low pressure the relaxation of lens tissue causes a slow decrease of the measured load. Instantaneously after laser treatment the measured forces drop by up to 10 % caused by the change in lens structure, even in young flexible porcine lenses. The decrease of the measured load after treatment shows a linear dependency on the total number of applied laser spots placed within the lens nucleus.
Conclusions: We have evaluated the influence of fs-laser treatment onto stiffness of porcine lenses that scales almost linear with the number of applied laser spots. To increase lens flexibility and to renew accommodation, applying multiple layers of separate disrupted tissue spots within the lens nucleus appears to be a promising treatment for presbyopia.
Commercial Relationships: Robert Kammel, None; **Stephanie Bühren**, None; **Roland Ackermann**, None; **Stefan Nolte**, None; **Andreas Tünnermann**, None
Support: BMBF Grant ID 13N8831

Program Number: 850 **Poster Board Number:** D998
Presentation Time: 11:15 AM - 1:00 PM
Improving Presbyopic Eye Accommodative Response by Softening Mid-Periphery of the Crystalline Lens via Ultra-Fast Laser
Valas Teuma, Gary Gray, Keith Edwards, Steve Bott, Randy Frey. R&D, Lensar Inc, Orlando, FL.
Purpose: The purpose of the study is to explore the utility of using a femtosecond laser to restore accommodative capacity through softening of the mid-periphery of crystalline lens tissue, in custom shapes designed to increase lens curvature in the accommodated state. The curvature would then decrease under zonular tension for distance vision.
Methods: Finite Element Analysis was used to generate models of human lenses representing subjects of ages 35, 45 and 55 years old. The models were used to predict refractive change and accommodative response when a volume of lens tissue of a specific shape in the lens mid-periphery was softened. A femtosecond laser was programmed to deliver custom shot patterns designed to photodisrupt lens tissue in a manner resembling that of the shapes predicted by the FEA modeling to generate the highest accommodative response. Laboratory testing was conducted on porcine eyes to compare the changes in anterior lens curvature resulting from application of the custom shot patterns with the FEA prediction. The same custom shot patterns were applied in clinical trials to human subjects with refractive changes measured subjectively and objectively.
Results: FEA predicts refractive power increases of 3.5 D and 3.6 D, respectively, for the 45 YO and 55 YO presbyopic model eyes. The change for a 35 YO normal eye was much smaller: 2 D. The femtosecond laser-treated porcine eyes showed an average 1.5D increase of refractive power. Clinical treatment of the eyes of human subjects with the same custom patterns resulted in significant increases in refractive power measured both subjectively and objectively.
Conclusions: Finite Element Modeling predicts that femtosecond lasers can be used to change lens curvatures by altering biomechanics of tissue in the mid-periphery of the lens and further predicts accommodative response when the treated model lens is not subjected to zonular tension. Femtosecond lasers applying custom patterns to porcine lenses and to eyes of human subjects resulted in increases in refractive power in reasonable agreement with the FEA predictions.
Commercial Relationships: Valas Teuma, LensAR Inc (I, E); **Gary Gray**, LensAR Inc (I, E); **Keith Edwards**, LensAR Inc (I, E); **Steve Bott**, LensAR Inc (I, E); **Randy Frey**, LensAR Inc (I, E)
Support: None

Program Number: 851 **Poster Board Number:** D999
Presentation Time: 11:15 AM - 1:00 PM
Evaluation Of The Accommodative Performance Of The Crystalens HD500
Marcus Mittag, Ria Beck, Oliver Stachs, Rudolf Guthoff. Universitaetsaugenklinik Rostock, Rostock, Germany.
Purpose: To evaluate the ability to accommodate and visual outcomes in patients after cataract surgery using the accommodating IOL Crystalens HD 500.
Methods: Three patients, aged 65-74 years, underwent cataract surgery followed by implantation of the Crystalens HD 500 in both eyes and were followed up for 6 months. Exclusion criteria were any eye pathologies and corneal astigmatism over 0.75 dpt. Uncorrected (UDVA) and corrected (CDVA) distance visual acuity and distance corrected intermediate (DCIVA / 80 cm) and near (DCNVA / 40cm) visual acuity were measured using ETDRS and Jaeger charts. Anterior chamber depth (ACD) was obtained using partial coherence interferometry (PCI) with an optical stimulus, objective accommodation was determined with wavefront aberrometry and subjective accommodation using defocus curves. These were performed at photopic (30 cd/m2) and mesopic (3 cd/m2) conditions. Pupil diameters were extracted from the aberrometry data.
Results: DCNVA was in mean 0.317+/- 0.07 logMAR under photopic and 0.549 +/- 0.14 logMAR under mesopic conditions 6 months post-op. Spherical equivalent of all eyes was in mean -0.56 dpt. +/- 0.39 dpt. Mean change of ACD focusing a -3 dpt. target was 11.67 +/- 8.78 µm. No reproducible changes in higher and lower order aberrations were observed in the aberrometry. The mean change of pupil diameter focusing a 40 cm target was -0.145 +/-0.229 mm under photopic and 0.716 +/-0.223 mm under mesopic conditions. The subjective accommodative range was 1.58 +/- 0.37 dpt under photopic and 1.25 +/- 0.27 dpt under mesopic conditions.
Conclusions: No objective accommodative action of the IOL, neither a forward shift nor an “arching” or similar change of the IOL configuration, was observed. The DCNVA decreased with an increase of the pupil diameter under mesopic conditions. All patients had minimal astigmatism at least in one eye. Pseudoaccommodative effects, i.e. pinhole effect combined with minimal astigmatism and slight myopia could explain the subjective accommodative range.
Commercial Relationships: Marcus Mittag, Bausch&Lomb (F); **Ria Beck**, None; **Oliver Stachs**, None; **Rudolf Guthoff**, Bausch&Lomb (F)
Support: None

Program Number: 852 **Poster Board Number:** D1000
Presentation Time: 11:15 AM - 1:00 PM
Preliminary Investigation On The Dynamics Of Accommodation In An *Ex Vivo* Accommodation Simulator: Natural Versus Refilled Lens
Saramati Narasimhan[1,2], Altricia Wilson[1], James Nearing[3], Christian Billotte[4], Jason Watling[5,6], Fabrice Manns[1,2], Robert C. Augusteyn[7], Arthur Ho[5,8], Jean-Marie A. Parel[1,7]. [1]Ophthalmic Biophysics Center, Bascom Palmer Eye Institute, Univ of Miami Miller School of Medicine, Miami, FL; [2]Biomedical Optics and Laser Laboratory, Department of Biomedical Engineering, Univ of Miami, College of Engineering, Coral Gables, FL; [3]Department of Physics, University of Miami, Coral Gables, FL; [4]Service d'Ophtalmologie, CHU Caen, University of Caen, Caen, France; [5]Brien Holden Vision Institute, Sydney, Australia; [6]Adventus Technology (Australia) Pty Ltd, Sydney, Australia; [7]Vision Cooperative Research Centre, Sydney, Australia; [8]School of Optometry and Vision Science, University of New South Wales, Sydney, Australia.
Purpose: To evaluate the feasibility of quantifying the dynamics of accommodation in a lens stretcher (EVAS) in a natural (NL) and refilled (RL) lens.
Methods: The accommodative apparatus of a human eye (age=14yr, PMT 72hr) was mounted in EVAS and stretched to a maximum radial displacement of 2.5mm. After settling for 20s, the load was released at a rate of 0.5mm/s. The coronal view during release was recorded using an operation microscope coupled with a video system. Ciliary and capsule diameters were measured on 146 frames over the 5s release period. At the end of the experiment, the lens was extracted, the empty capsule refilled with a siloxane-based polymer, and the experiment was repeated on the refilled lens.
Results: The change in capsule diameter (CD) was greater for the RL than the NL (0.66mm compared to 0.45mm respectively, over 4s). Fitting to an offset exponential decay model, the accommodative change in CD of the NL exhibited a greater exponential curvature ($CD=9.43+0.699e^{-0.653t}$) than the RL ($CD=8.17+1.61e^{-0.183t}$). This suggests that the NL has a marked viscous component

in its mechanical properties while the RL is much closer to being elastic. A similar response was seen for the change in diameter of polymer outline in the RL.
Conclusions: The dynamic response of accommodation can be quantified on an EVAS using video-image analysis. Quantitative and qualitative differences can be seen in the accommodation response of NL and RL on the EVAS. The NL exhibits a visco-elastic type response while the lens refilled with siloxane-based polymer exhibits a more elastic behaviour.
Support: NIH 2R01EY14225; Australian Federal Government CRC Program (Vision CRC); NIH P30EY14801; Florida Lions Eye Bank; Research to Prevent Blindness; Henri and Flore Lesieur Foundation (JMP).
Commercial Relationships: Saramati Narasimhan, None; **Altricia Wilson**, None; **James Nearing**, None; **Christian Billotte**, None; **Jason Watling**, Adventus Technology (Australia) Pty Ltd (E), Patent (P); **Fabrice Manns**, None; **Robert C. Augusteyn**, None; **Arthur Ho**, None; **Jean-Marie A. Parel**, None
Support: NIH 2R01EY14225; Australian Federal Government CRC Program (Vision CRC); NIH P30EY14801; Florida Lions Eye Bank; Research to Prevent Blindness; Henri and Flore Lesieur Foundation (JMP)

Program Number: 853 **Poster Board Number:** D1001
Presentation Time: 11:15 AM - 1:00 PM
Comparison Of Visual Outcomes Following Cataract Surgery With Impantation Of Lentis Mplus Multifocal Intraocular Lens And Crystalens HD Accomodating Intraocular Lens
Piero Ceruti, Gabriele Vizzari, Marco Toscani, Giorgio Marchini. Eye Clinic, University of Verona, Verona, Italy.
Purpose: To compare the postoperative visual outcomes after cataract surgery in patients implanted with Lentis Mplus multifocal intraocluar lens (IOL) versus patients with Crystalens HD accommodating IOL.
Methods: 30 eyes from 15 patients implanted with Crystalens HD (Bausch&Lomb, Rochester, NY, USA) and 30 eyes from 15 patients with Lentis MPlus (Oculentis GmbH, Berlin, Germany) were evaluated in a cross-sectional study. Each patient underwent standardized phacoemulsification with in-the-bag implantation of IOL. Uncorrected distance visual acuity (UCDVA) was measured using a Snellen table. Uncorrected intermediate visual acuity (UCIVA) was assessed at 80 cm with a Snellen chart. Uncorrected near visual acuity (UCNVA) was obtained at 40 cm using a Jaeger chart.
Results: After a mean follow-up period of 85 ± 25.4 days, the mean UCDVA for the Mplus group improved significantly after surgery changing from 0.57 ± 0.12 to 0.91 ± 0.08 (30% of the eyes achieved 1.0) ($p<0.001$), the mean UCIVA was of 0.94 ± 0.21 and the mean UCNVA was 1.65 ± 0.67 J (with 53,3% of the eyes attaining J1 and 40% J2). The Crystalens HD group obtained a changing of the mean UCDVA from 0.28 ± 0.06 to 0.91 ± 0.12 (34% of the eyes achieved 1.0) ($p<0.001$), a mean UCIVA of 1.01 ± 0.12 (with 46.2% of the eyes achieving 1.25) and a mean UCNVA of 1.94 ± 0.78 J (with 30.8% of the eyes attaining J1 and 40.2% J2).
Conclusions: UCDVA improved significantly after surgery in all patients. The Lentis MPlus provided a better near visual outcome than Crystalens HD, with 100% of the eyes achieving J3 or better without spectacle correction, while Crystalens HD allowed a better UCIVA.
Commercial Relationships: Piero Ceruti, None; **Gabriele Vizzari**, None; **Marco Toscani**, None; **Giorgio Marchini**, None
Support: None