Commercial Relationships: Richard A. Regueiro, None; **Christopher J. Bay**, None
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Program Number: 1351 **Poster Board Number:** A23
Presentation Time: 8:30 AM - 10:15 AM
Hydrostatic Skeleton Model of Accommodation
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Purpose: Estimate the residual stresses in the lens capsule as a function of age.
Methods: A hydrostatic skeleton one in which an enclosed incompressible fluid acts as a skeletal element and is acted on by its surrounding prestressed muscular membrane which serves as the agonist muscle. The hydrostatic pressure of the fluid induces residual stress in the membrane. The shape of the hydroskeleton is determined by the interaction of external forces, fluid pressure, and membrane properties. The geometric model of accommodation (Reilly and Ravi, Vision Res. 2010) was recast as a hydrostatic skeleton model of accommodation, enabling an estimation of the residual stresses in the capsule during accommodation. The previously-derived area dilation-based force calculation (Ravi and Reilly, ARVO 2010) was augmented by the inclusion of a residual stress term. This allowed an estimate of residual stress by determining the modulus at which the model-predicted lens/capsule dilation force was equal to the experimental stretching force (Manns et al., IOVS 2007) corrected for the presence of connective tissues.
Results: Inclusion of the residual strain in the stretching force formulation allowed reconciliation of the geometric model of accommodation with measurements in the literature. Residual stress within the lens capsule increases with age, implying an increase in internal pressure. This increased internal pressure results from lens growth. During accommodation, the capsule relaxes to recover its natural force balance between residual membrane stresses and pressure exerted by the lens fiber cells.
Conclusions: Inability of the capsule to recover to a sufficiently accommodated state is the root of presbyopia. Age-related residual stress increases in the lens capsule are driven by natural lens growth. Due to the intrinsic constitutive behavior of the lens capsule (i.e. concave upward; Burd, Biomech Model Mechanobiol. 2009), increased residual stress necessarily increases the force required to deform the capsule. This perspective also resolves the apparent physiological anomaly of muscle contractility resulting in decreased tension by recasting the capsule as a transparent muscle proxy. This finding may also have implications for lens refilling as a treatment for presbyopia.
Commercial Relationships: Matthew A. Reilly, None
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Presentation Time: 8:30 AM - 10:15 AM
Objective Measures Of Accommodation Error In Aberrated Eyes
Jesson Martin[1], Norberto Lopez Gill[2], Tao Liu[1], Arthur Bradley[1], Larry Thibos[1]. [1]School of Optometry, Indiana University, Bloomington, IN; [2]University of Murcia, Murcia, Spain.
Purpose: Our goal is to improve methodologies for using wavefront error measurements to determine the eye's accommodative response to visual stimuli
Methods: We define refractive state of an accommodating eye as the stimulus vergence required to maximize retinal image quality (Lopez-Gil et al, 2009, *J Optom,* **2**: 223). Given a wavefront error map (relative to a reference sphere of infinite radius), we compute refractive state by optimizing the amount of defocus that must be added to the measured wavefront to maximize retinal image quality according to some scalar metric (Thibos et al, 2004, *J. Vis.* **4**(4):329). The difference between this optimum stimulus vergence and the actual stimulus vergence (always negative for real stimuli) is the error of accommodation (i.e. "lead" or "lag"). Our wavefront approach avoids the usual paraxial approximations by taking into account pupil size, higher-order aberrations, and the specific measure of image quality deemed appropriate for the visual stimulus and/or task under investigation.
Results: Accommodative response, as defined by the refractive state of the accommodating eye, is not determined uniquely by a wavefront error map. Instead, refractive state depends strongly on the metric of image quality chosen for the analysis. In all tested eyes, a paraxial measure of image quality makes the refractive state less negative than stimulus vergence when viewing distant targets, which results in a propensity for accommodative lag. Conversely, paraxial measures of refractive state are more negative than stimulus vergence when viewing near targets, which results in a propensity for accommodative lead. These propensities are typically reduced, and may even be reversed, for measures of image quality that assign weight to the whole pupil, not just the paraxial region. For example, the Zernike refractive state (specified by the Zernike coefficient for defocus) is more negative than paraxial refractive state when viewing distant targets and more positive when viewing near targets (lead at distance and lag at near).
Conclusions: The accommodative response of an aberrated eye depends on the metric used to compute refractive state from wavefront aberration maps. Functional implications drawn from measured accommodative lead and lag are therefore conditional upon the appropriate choice of image quality metric.
Commercial Relationships: Jesson Martin, None; **Norberto Lopez Gill**, None; **Tao Liu**, None; **Arthur Bradley**, None; **Larry Thibos**, None
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Presentation Time: 8:30 AM - 10:15 AM
Double-pass Accommodative Response Measurements In A Wide Age Range Population
Jaume Pujol[1], Mikel Aldaba[2], Merittxel Vilaseca[1], Fernando Díaz-Doutón[1], Montserrat Arjona[1]. [1]CD6-Optica i Optometria, Universitat Politecnica Catalunya, Terrassa, Spain; [2]CD6, Univ Politecnica de Catalunya, Terrassa, Spain.
Purpose: To measure accommodative response (AR) in a wide age range population by means of a double-pass system.
Methods: 84 patients were enrolled in this study, with a mean age (± SD [range]) of 34.55 ± 12.04 years (15 to 55 years), a mean subjective manifest spherical refraction of -0.99 ± 1.72 D (-8.00 to +3.00 D), a mean subjective astigmatic refraction of -0.46 ± 0.46 D (0 to -1.75 D) and a mean best corrected visual acuity of 1.13 ± 0.10 (0.9 to 1.2). Patients were corrected according to their subjective manifest 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 1 D. Accommodation was measured with an open field double-pass system aiming at the best double-pass image, whose vergence was then associated with the AR value.
Results: Patients were divided in four groups of different ages in order to perform the comparison: from 15 to 25 years, n = 24; from 26 to 35 years, n = 20; from 36 to 45 years, n = 20; and from 46 to 55 years, n = 20. As expected, we found that the AR decreased with age, with a noticeable fall in patients older than 35 years. We found higher AR than those previously reported by other authors using different techniques for the two younger groups. For example with a 5 D accommodative stimulation we found a mean AR of 4.93 ± 0.41 D for the 15 to 25 years group and of 4.52 ± 0.65 D for the 26 to 35 years group. The AR measured in the 36 to 45 years group was significantly lower and with a much higher dispersion; with 5D accommodative stimulation AR was 3.09 ± 1.22 D. The oldest group (46 to 55 years) reported lower results than those found in the literature, with a mean value of 1.01 ± 0.31 D when stimulating 5D.
Conclusions: We have assessed the AR in a wide age range population based on the retinal image quality measured with an open-field double-pass system. The measured AR was very high in young patients, decreased significantly in patients older than 35 years old and was very low in the oldest group. The differences with results available in the literature, which were obtained using other techniques, could probably be attributed to the fact that our measures are based on retinal image quality and are therefore not affected by pseudoaccomodation.
Commercial Relationships: Jaume Pujol, None; **Mikel Aldaba**, None; **Merittxel Vilaseca**, None; **Fernando Díaz-Doutón**, None; **Montserrat Arjona**, None
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Presentation Time: 8:30 AM - 10:15 AM
Validation of Accommodative Responses Measured with the EyeMapper
Ravi C. Bakaraju, Cathleen Fedtke, Klaus Ehrmann, Darrin Falk, Rebecca Weng, Padmaja R. Sankaridurg, Arthur Ho, Brien A. Holden. Brien Holden Vision Institute, Sydney, Australia.
Purpose: The EyeMapper is an instrument designed to perform fast, global aberrometry. This study compares the central refraction measurements for distance and near obtained with the EyeMapper, a Shin-Nippon NVision K5001 autorefractor (SN, Japan) and a Complete Ophthalmic Analysis System (COAS-HD, Wavefront Sciences, USA) aberrometer with the dynamic stimulation aberrometry (DSA) device (Optana, Germany).
Methods: Twelve participants, aged 18 to 30 years, with spherical equivalent ranging from plano to -6.00D (mean -1.85D ± 2.29D) and astigmatism <1.00D were enrolled and ametropic eyes were corrected using 1-Day Acuvue Moist soft contact lenses (Johnson & Johnson, USA). Measurements for distance and accommodative demands of 3, 4 and 5D were performed (5 repeats) using the three instruments. Fixation targets were a high contrast back-illuminated modified (8 arms) Maltese Cross, 6/12 and 6/24 Snellen Letter E. While the internal EyeMapper targets were telecentric, target sizes for the SN and COAS were adjusted for their respective distances. The order of testing with the instruments and target presentation was randomized. Only the right eyes were measured with the left eyes occluded during the measurement.
Results: For distance, the EyeMapper results were significantly more negative (0.60D, p<0.01) compared to SN, but were not different to COAS (p>0.05). Mean