Optical self-adjustment of the human eye – preliminary study

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The significance of ocular mechanics to optics of the eye has important implication for understanding the dynamics of the eye that needs to maintain ocular image quality . Eye dynamics is controlled by intraocular pressure (IOP) fluctuations associated with the ocular pulse,daily rhythm and pathological high levels of IOP (glaucoma). These cause the corneal apex shift relative to the retina and the change of the axial corneal radius. This study concerned on simulation of changes in corneal radius and the relative position of the cornea and crystalline lens required for maintenance of the image quality (optical self-adjustment hypothesis) when the eye is subjected to variations in IOP.

Methodology: Gullstrand-Le Grand Eye Model was assumed for analysis. The changes of the anterior chamber depth (ΔD), the thickness of vitreous body (k.ΔD, k is a parameter) and corneal radius (ΔR) were analyzed and their relations were calculated to fulfill the self-adjustment hypothesis (fig.1). The next step was to predict the relative changes (isotropic) in the geometrical parameters of the eye depending on the different location of a neutral point (stationary point during changes of IOP).

Results: The relation between RΔ/ΔD and parameter k is linear ($p<0.001$). This relation allows for the prediction of the relative changes in optical system to maintenance focus on the retina (optical self-adjustment of eye). The value of k parameter depends on the location of the neutral point and the geometry of the eye.

Conclusions: The analysis showed that for measured ΔR/ΔD and parameter k, the linear equation could be used for verification whether optical self-adjustment hypothesis is fulfil. It is the first approach to the description of the dynamic of the optical system and it need be verify in the clinical study and simulated in advance numerical model of the eye.

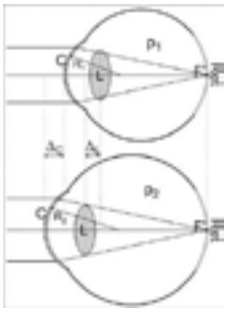

Fig. 1 Optical self-adjustment hypothesis explanation. F' – focus of the optical setup of the eye, Ret – retina, p1,p2 – two different intraocular pressures (p2>p1), C – cornea, ΔC – cornea displacement, R1,R2 – radii of corneal curvatures corresponding the pressures p1,p2, L – eye lens, ΔL – eye lens displacement.

Biography

Marcelina K. Sobczak was born in Kalisz, Poland in 1993. She received an Engineer's degree in Ocular Optics and a Master's degree in Optometry from the Faculty of Fundamental Problems of Technology at Wroclaw University of Science and Technology. She is currently working toward a PhD degree in the same Faculty. Her early research revolved around design an optical system with dynamic magnification and an eye movements analysis in the process of tracking horizontal moving point.Her current research interests include a compensatory torsional eye movements analysis, an optical self-adjustment of the human eye and birefringent properties of a human cornea. First results of her research will be published in Journal of the Optical Society of America A.She is a member of the Visual Optics Group, SPIE and OSA Societies. She has experience in numerical analysis of images, especially in Matlab.

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