Abstract

This work is interdisciplinary and covers the areas of physics-optics as well as medicine and medical physics – ophthalmology. In more detail, the work focuses on the analysis of changes in optical parameters, a dynamic and structurally advanced optical element, which is the cornea, which has been subjected to the process of deliberate deformation using an orthocelatological lens.

The theoretical part of the thesis depicts: the optical system of the measuring eye along with the basic physical models used to describe the course the light rays in such an eye: the cornea as the most significant element of this optical system: errors of refraction as basic eye irregularities: methods of analysis and types of aberrations of optical systems: application of Fourier series in the description of the corneal topography: the history of orthokeratology and the current state of knowledge on short and long term changes cased by the application of arthokeratological lenses.

After the theoretical introduction, the thesis involves a description of theses and the purpose of the work, and the applied research methodology is characterized.

The objective of the study was to determine the boundary conditions of the lens assemly with complex geometry and to trace the changes that occur as a result of deformation of one of the optical surfaces caused by the use of orthocelatological correction. The analysis of the resulting changes was to be performed both by experimental measurements and theoretical analysis using one of the theoretical models, after introducing the necessary modifications. In accordance with the assumptions, learning about the dynamics and mechanisms of the ongoing processes was to allow for the clarification of the selected criteria related to the qualification for wearing lenses, checking the influence of introduced deliberate deformationson the quality of he mapping and to enable to specify the mechanisms underlying the metod used.

The realization of the goal of the work was supposed to be achieved as a result of the conducted experiment, the condition of which were ilustrated in the depiction of the research methodology used.

The experimental part of the work includes the outcomes and their discussion. The results of the research were divided into parts and presented in the form of descriptions of : initial conditions of the system, short-term and long–

term changes due to deformation of the cornea; the influence of the changes on the quality of the retinal image.

The analysis of the literature on contraindications to the use of visual aids, combined with the results of marginal (initial) tests, made it possible to refine the adopted qualification criteria for the use of orthokeratological correction. The adopted criteria have been tabulated.

Based on the outcomes obtained from the so-called the qualification procedure, it was found that the otained results allowed: to qualify the patient for the use of visual oad; define the boundary (initial) conditions of the element of the optical system of the eye, which is the cornea efore the process of its deformation; determine the individual parameters of the orthokeratological lenses used in the experiment.

The depiction of the short-term changes covered involved the period of the first day of using the visual aid(minimum 6 hours of their use). Then the description of long-term changes included the characteristics of selected time points up to 3 months from the first aplication of orthokeratological lenses.

As part of the research, for individual time points, the following were determined: refractive status and eye biometry, topography, densitometry, pachymetry and aberrometry of the cornea. These studies allowed: to define the changes in the physical parameters of the cornea as a function of the time of using the lenses or to particularize the mechanism of topographic changes caused by the use of orthokeratological lenses, to analyze the changes in the quality of vision caused by the use of visual aids, and thus its effectiveness, to conduct an analysis using the Fourier series of topography and indicate its role in the context of the analysis of the quality of lens fitting, as well as determine the impact of the use of a corrective spherical orthokeratological lens on corneal aberrations.

In the succeeding part, the measurements of physical parameters, as well as the data described in the aspherical eye model, according to Navarro, were used to build the eye model, and more specifically: the Navarro model with the refractive error corresponding with its measurement to its to the attained defect from experimental measurement; and models modified to substantial parameters before and after orthokeratological correction .The use of the models, thanks to the analysis of the macula of the lowest scattering and the corresponding interferograms, made it feasible to concede to the impact of the applied orthocorrection on the quality of the retinal image.

The conducted research allowed to accomplish all research objectives. On the basis of the presented studies as well as their analysis, the qualification criteria were precised on the basis of measurable, physical parameters of the eye and their

results are presented in tabular form; it was determined that the main mechanism that caused changes in the geometry contributed to plastic changes without the significant change in the thickness of the cornea in the central zone (rheorogical mass migration of the corneal epithelium), which indicated the compliance with the mechanism with the model described by Reim; thanks to the use of the aberrometric analysis and oresented modifications to the aspherical eye model according to, the effect of influence of the deformation on the quality of the retinal image was illustrated. The applied methodology also indicated the high applicability of the ray-tracing technique and the depicted model (with represented modifications) in the theoretical description of the optical system of the eye after orthokeratology.

It should be also noted, that achieved outcomes and the conclusions presented on their basis in terms of the mechanisms of forced adaptation of the shape of the cornea to the curvature of the posterior surface of the orthokeratological lens, they open up the chance of searching for new, permanent and non-invasive methods of correcting vision defects.

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