Abstract

Visual function is decreased due to glistening and subsurface nanoglistening (whitening) after intraocular lens (IOL) implantation into human eyes. Glistening means fluid filled micro-sized vacuoles, on the other hand, whitening is nano-sized vacuoles in IOL which lead to light scattering and affect human's vision quality. Glistening observation and light scattering in IOL mainly depend on the characteristics of glistenings which are size, shape, refractive index, and number of glistenings. Furthermore, glistening occurrence in IOL depends on various conditions. Moreover, vision quality can also be different based on these facts. Glistening is increasingly over time and so it cannot be stopped by medicine and treatment. The best treatment for glistening is surgical removal and thus, the effect of glistening in IOL is required to study. We approach the light scattering problem from time and cost-effective way which evaluate the visibility of IOL.

Several researches studied glistenings from ophthalmology and assessed the consequence of glistening in vision quality by clinical tests such as contrast sensitivity, visual acuity and glare testing or wavefront measurements of the human eyes. This kind of research is required to participate by the patients and assessed light scattering in IOL by using clinical equipment such as C-Quant, spectrometer and Scheimpflug photography and thus, it is time consuming and costly to study. Moreover, these studies report the light scattering from single sphere particle but multiple particles scattering for IOL are not considered. For the real light scattering problem in IOL, light transmittance to the retina which can interfere by glistenings is not only for single particle, but also multi-glistenings. In multiple glistenings, the distance between particles are important in light scattering measurement of IOL. If the particles are brought closer together, so that their surfaces are from one another, then their scattering volumes begin to overlap. Therefore, the total scattering volume from the two glistenings is less than the sum of the two-individual scattering volumes. When light that enters the overlap volume, light can scatter less efficiently than light that enters a part of the non-overlapping scattering. Finally, there is no report to evaluate the visibility of IOL with glistenings to solve each of the above problems.

This research proposes optical model to study the glistenings in IOL with visibility evaluation from multiple light scattering with T-matrix method. However, this optical model considers the important facts to overcome the real problems which are not yet developed by the previous studies. When glistening numbers are grown, light scatter problem may occur inside the lens and vision quality will be degraded. Firstly, visibility function is evaluated based on the glistening characteristics in the optical model. When microvacuoles are densely located in IOL, light scattering for single particle is not sufficient and multiple light scattering is important to be considered. Therefore, multiple light scattering of glistenings are calculated by using T-matrix theory. Moreover, light transmission through Intraocular lens (IOL) with glistenings and whitenings are also computed. In fact, the proposed model study the characteristics of laboratory-induced glistenings under temperature changes, calculate the light scattering from multiple light scattering theory and simulate the light transmission to the retina.

Although light scattering is measured from different approaches, there is no research of light scattering effects differs depending upon the human activities. In this research, the most important approach is visibility evaluation in considered from human activities such as driving at night, studying and walking. Furthermore, this optical model evaluates visibility functions of IOL with glistenings through glare and quality of retinal image contrast. Glistenings give arise light scattering in IOL and as a result of intraocular light scatter called straylight in retina, disability glare. The quality of human vision depends on the image on the retina. Disability glare can cause the loss of retinal image contrast due to glistenings in IOL. Therefore, reduction of contrast due to glistenings are evaluated for visual functions and assessed the quality of the lens degradation. As a summary, this research combines all the important facts to model the visibility evaluation of intraocular lens with glistenings by microscopic image analysis based on light scattering model.

Key Words: **Visibility Evaluation, Optical Model, Multiple Light Scattering, T-matrix, Glistening**