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学 位 論 文 要 旨
Dissertation Summary

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論　文　名: Development of Ocular Surface Tribometer and Computational Program for Determining Frictional Characteristics of Human Ocular Surfaces

(Dissertation Title)

Dry eye syndrome is considered to be related to friction on human ocular surfaces. In dry eye, a deficiency of the tear fluid causes continuous friction between the eyelid and the ocular surface during blinking. As the tear fluid is decreased, the friction between the eyelid and the ocular surface is increased. Then the friction during blinks can damage the ocular surface. Therefore, many researchers have been interested in examining the mechanical friction on human ocular surfaces to contribute to practitioners in treating dry eye syndrome patients. However, the problem of friction is very complex. Although many researchers have examined the mechanical friction on human ocular surfaces, frictional characteristics of the human ocular surface have not been clarified. Therefore, it is necessary to investigate the plight of ocular surfaces where friction is generated and the associated frictional characteristics in order to solve the dry eye problem.

Hence, the main purpose of this research is to determine frictional characteristics of human ocular surfaces. In this research, frictional coefficient of the human ocular surface is considered related to the viscosity of tear film, the velocity of nictation, and the palpebral pressure. Then an ocular surface tribometer capable of measuring the moving velocity of the probe, normal forces, and frictional forces on human ocular surfaces was developed. A new number that capable of calculating the frictional coefficient of the human ocular surface was proposed. Then by incorporating the proposed new number, a mathematical model describing frictional coefficient of the human ocular surface was also proposed.

The ocular surface tribometer developed in this research consists of two main parts, namely hardware and software. The hardware consists of an electrostatic capacity sensor as a two-axis force sensor, a frame to fix a face, an encoder, a microcontroller, and a laptop-computer. The software consists of a data logger software. In this research, the ocular surface tribometer was used to measure normal forces, frictional forces, and displacements of the probe on six healthy subjects. The data logger was used to process the measured data. By using the data logger, the data on normal forces, frictional forces, and displacements of the probe were sampled synchronously.

In this research, the computational program employing BSG-Starcraft of PSO and LSM was developed. Using the proposed new number in employing the BSG-Starcraft of PSO and LSM, the frictional characteristic curves of human ocular surfaces were determined. In addition, the frictional characteristic curves of human ocular surfaces were also determined by using other methods: the Hersey Number in employing Least-Squares Method (LSM) and the proposed new number in employing the Genetic Algorithm and LSM. Then the obtained frictional characteristic curves were compared.

This research has shown that the frictional characteristics of human ocular surfaces could be classified into three types: the fluid lubrication where the eyelid and ocular surfaces are fully separated by the tear layer, the mixed lubrication where a part of the eyelid and ocular surfaces is supported by the tear layer and in the other part, the eyelid surface may be in contact with the ocular surface, and the lubrication containing both the mixed and fluid ones. In both the mixed lubrication and the lubrication containing the mixed and fluid ones, the appropriate frictional characteristic curves could be obtained for the three methods. While, in the fluid lubrication, the appropriate frictional characteristic curves could be obtained for the two methods using the proposed new number, but the appropriate ones could not be obtained for the method using the Hersey Number.