Evaluation of mitochondrial function of the retinal tissue with FLIO

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Fluorescence Lifetime Imaging Ophthalmoscopy (FLIO) is an innovative tool that enables the measurement of the fluorescence lifetime of human fundus. Due to its potential to measure the fluorescence lifetime of metabolic cofactors like flavin adenine dinucleotide (FAD), FLIO is considered a useful method to measure metabolic changes of fundus tissue, and thus might be utilized for the early diagnosis of retinal degenerative disorders. However, it is still unclear, which kind of metabolic change is reflected in the florescence lifetime on FLIO, and thus clinical interpretation is still difficult, even though clinical data have been accumulated in last years.

Mitochondrial dysfunction is getting more attention, since it may play an essential role in pathogenesis of different health problems and diseases, such as cognition decline, diabetes mellitus, cardiovascular diseases, and ocular diseases like age-related macular degeneration and diabetic retinopathy. In clinical Ophthalmology, however, there is no method to detect mitochondrial function to date.

Thus, our final goal is to establish the method to utilize the FLIO for the assessment of metabolic status, especially to evaluate mitochondrial function. For that purpose, we attempt to explore the potential of the FLIO to detect the metabolic changes of the retinal pigment epithelium (RPE), the cell monolayer that is required to have a high metabolic activity to preserve retinal health.

The results using an uncoupler (FCCP) showed a quick and reversible change of fluorescence lifetime of the ex-vivo RPE on FLIO in a short time range. The several small defects (200 μm diameter) of the RPE via non-thermal laser irradiation induced the change in the fluorescence lifetime not only at the area of the wound, but also the larger area at 24 h after irradiation. These results suggest that FLIO might be applied to measure the changes in metabolic activity of retinal cells induced by different stimuli, in order to assess the mitochondrial function in individuals, or to assess the toxicity or efficacy of mitochondria-targeting drugs in clinical practice.