Automated detection of selective retina therapy impact in optical coherence tomography scans

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Selective retina therapy (SRT) is a promising approach for the treatment of degenerative retina diseases such as age-related macula degeneration and diabetic retinopathy. Still in development, the method is lacking in real-time dosimetry control. A MATLAB algorithm was developed for an automatic detection of laser pulse induced changes in optical coherence tomography (OCT) M-scans.

Introduction

In contrast to photocoagulation, SRT targets only cells that can regenerate, leaving fragile retinal cells such as photoreceptors unaffected. However, the current SRT method lacks appropriate real-time dosimetry control. Simultaneous acquisition of retinal OCT M-scans may solve this problem.

Objective

Energy dosimetry during SRT laser treatment is important: a too weak laser shot fails to kill the defect RPE cells, while too high energy doses result in photocoagulation and therefore a loss of vision at the treatment spot. First OCT M-scans analyses during SRT treatment showed signal variations at the treatment spot, expected to correlate with the laser energy doses. Therefore, it is the objective to develop a reliable algorithm for detecting signal washouts.

Methods

SRT was performed on ex-vivo porcine eyes and OCT M-scans were acquired using a custom Lutronic R:GEN laser and OCT setup. First, image treatment techniques were performed to facilitate visual identification of the signal washouts. Secondly, a derivation filter and statistical approaches were selected and implemented in an automatic signal detection MATLAB algorithm. The algorithm has been applied to several OCT M-scans of SRT treated porcine retina to select the best parameters.

Results

An algorithm was written for automatic signal washout detection in OCT M-scans. Its sensitivity and specificity is adjustable by changing a threshold value. A general threshold value was found which provides reliable signal washout detection on various M-scans. In addition, the signal washouts were analyzed and classified according to the energy dose of the laser pulses.

Conclusion

First tests show that OCT may allow real-time dosimetry control for SRT. With automatic signal detection, the SRT laser could be stopped as soon as the desired effect on the targeted cells is detected and before unnecessary damage is inflicted. For a reliable system, the level of correlation between the detected signals and the laser energy dose is to be determined in further research.

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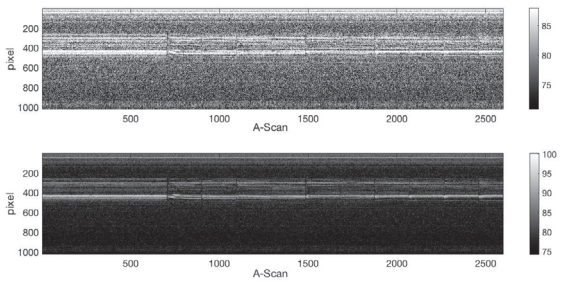
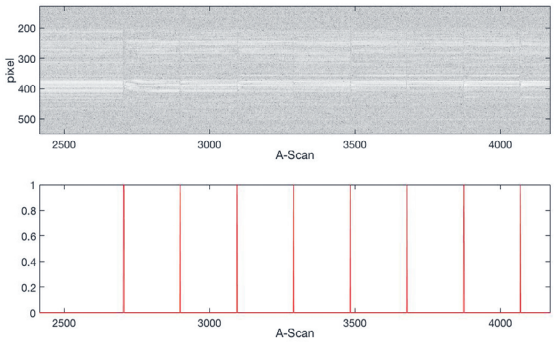


OCT M-scan without (top) and with noise reduction (bottom), about 20 microseconds between each A-scan.



OCT M-scan (top) and automatically detected signal washouts (bottom).