Differentiation of myopia progression in the myopic sclera using high-frequency quantitative ultrasound

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Background, Motivation and Objective

As myopia progresses, posterior eye elongation affects the microstructural properties of the sclera. High-frequency quantitative ultrasound (QUS) can quantify these changes non-invasively. A previous study demonstrated that myopic eyes could be diffirentiated from healthy based QUS estimates. This study investigated the use of 80-MHz QUS to elucidate the microstructural changes occurring in the posterior sclera of a guinea pig (GP) model of myopia.

Statement of Contribution/Methods

Three groups of artificially-induced myopia in the right eye (RE) were designed: at 1 week of life, REs underwent either 1 week of lens-induced myopia (1wk LIM, n = 9), 2 weeks of lens-induced myopia (2wk LIM, n = 9), or three weeks of form deprivation myopia (3wk FDM, n = 6). On the last day of treatment, refractive error (REr) and axial length (AXL) were measured *in vivo*. Following euthanasia, both eyes were enucleated and raster scanned using an 80-MHz transducer to acquire 3D radio-frequency (RF) data. The transducer had a focal length of 2.2 mm, an f-number of 2, and a -6-dB bandwidth extending from 41 to 109 MHz. The mean and standard deviation of 4 QUS estimates were computed from the RF data. Effective scatterer diameter and acoustic concentration were derived by fitting a Gaussian scattering model, and Nakagami shape and scale were derived using a maximum-likelihood estimator. Statistical analyses were performed to evaluate correlations between QUS estimates, REr, and AXL.

Results/Discussion

Features plots of QUS estimates vs AXL or REr (Fig. 1) revealed statistically-significant correlations between AXL and a QUS Nakagami shape parameter (r = -0.55, p <10^{-4}), and REr and QUS spectral slope (r = -0.39, p = 0.004). Scleral re-modeling occurs with the development of long-term myopia as well as age-related mechanical change. The Nakagami shape parameter findings are consistent with this since the longest-term (3 week) group differed from the other two groups. These results suggest that QUS methods can be used to quantitatively characterize microstructural changes occurring in the posterior sclera during myopia development.

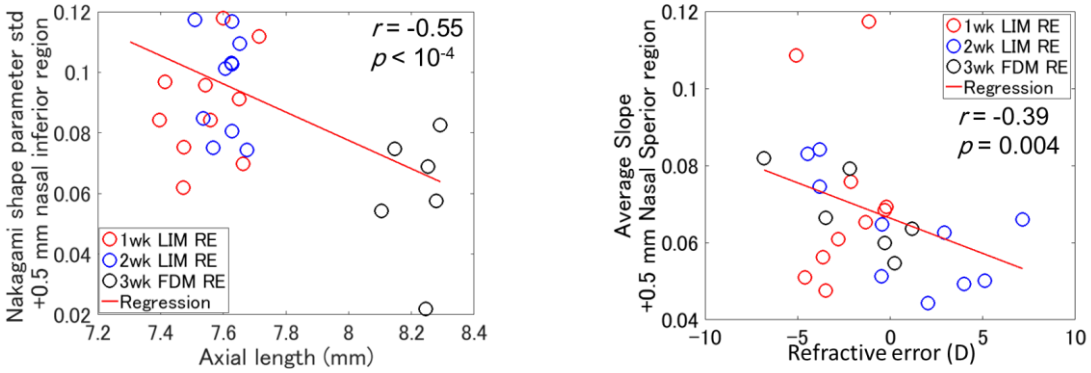

Fig.1 Correlation between Nakagami shape parameter and axial length (left) and slope and refractive error (right).