**Corneal biomechanical parameters in healthy and early stage keratoconus eyes from cross-meridian air-puff deformation OCT**

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**Purpose:** Detection of the localized biomechanical alterations in corneal biomechanics in early keratoconus (KC) will open new pathways for diagnosis and customized treatment options. A novel cross-meridian air-puff deformation Optical Coherence Tomography (OCT) imaging system was applied in healthy and early keratoconus patients. Deformation parameters, cross-meridian symmetry and estimated corneal biomechanical properties were evaluated as potential biomarkers for KC detection.

**Methods:** Cross-meridian corneal air-puff deformation images from 8 eyes of 8 subclinical and early stage KC patients (mean age 35yo), and 5 control (C) eyes from 3 healthy subjects (mean age 28yo) were collected using ImTOPScanner, a custom developed multi-meridian air-puff ssOCT system (Curatolo, BOE, 2020). Deformation images (3-x repetitions) along the horizontal (H) and vertical (V) meridians were collected during air-puff excitation. Custom routines were used for image segmentation and quantification (at maximum deformation) for both meridians: (1) Distance between the two peaks of the deformed cornea (PD), (2) Asymmetry in deformation area (ADA), (3) Deformation Amplitude (DA) Ratios (Vinciguerra, 2016) at distances 1, 1.5, 2mm from ~~the~~ corneal apex. Patient-specific eye models were generated, and inverse analysis was performed to quantify variation in corneal biomechanics. A second-order Ogden material model was used for these models. In case of abnormal corneal geometries, an algorithm was used to detect the pathology boundary and a different material model from the rest of the cornea was allocated to that region.

**Results:** All KC corneas showed lower PD (mean PDKC=4.70±0.03mm) than the control group (mean PDC=5.13±0.02mm), with PDH:PDV ratio of 1.01 for both groups. In KC corneas, the difference between the horizontal and vertical ADA was 1.5-fold higher than in the control group. The DA ratio was higher in KC than in control corneas at all distances (mean increase 0.10±0.04 (H) and 0.14±0.06 (V) for n=1mm; 0.28±1.11 (H) and 0.44±0.23 (V) n=1.5mm; 0.79±0.31 (H) and 1.71±1.17 (V) for n=2mm). The relative difference of the DA H/V ratios was higher in KC than in control corneas (2.2, 2.7, and 6.6-fold, for n=1, 1.5, and 2mm, respectively). Inverse analysis revealed the tangential modulus at 2% strain was 1.75±0.29 for KC corneas, 1.20±0.37 for KC cone areas and 1.43±0.18 for healthy corneas.

**Conclusion:** Cross-meridian air-puff corneal deformation OCT reveals differences between healthy and early stage KC patients. Parameters resulting from different deformations in horizontal and vertical meridians seem a well suited biomarker, independent of IOP. Results of inverse analysis compliment these parameters, with the disadvantage that inverse analysis is a long and complex process whereas parameters could be calculated immediately by the device and provide valuable diagnosis information.