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Regional variation of corneal stiffness with Keratoconus progression assessed by the Stress-Strain Maps

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Abstract

Purpose: To evaluate the regional corneal biomechanical deterioration with keratoconus (KC) progression as measured by the stress-strain maps (SSI).

Methods: In this retrospective record review, the preoperative of progressive KC cases that were submitted to corneal cross-linking were evaluated. All cases were examined with Pentacam HR and the Corvis ST (Oculus, Wetzlar, Germany). Significant progression was based on the Pentacam's ABCD system. The SSI Maps were built on the first and last visits using numerical modelling based on the finite element method. Through inverse analysis of patient-specific corneas, the regional variation of mechanical stiffness across the corneal surface was determined.

Results: A total of 29 eyes were included. The cases presented the disease in different stages with maximum anterior curvature (KMax) of 54.37 ± 4.55 D (44.5 – 64.4) and minimum thickness of 468.55 ± 27.74 μm (414 – 520). The mean age at the last exam before the CXL procedure was 20.1 ± 7.0 years (9 – 40). The mean time between the two examinations was 17.1 ± 17.1 months (1.4 – 58.4). The bIOP showed minimum non-significant alteration between the two exams (-0.08 ± 1.21 mmHg, range: -2.0 to 2.3, $p = 0.584$). The overall corneal stiffness as measured by SSI value in 8mm diameter presented slightly, but significant reduction from the first to the last exam (-0.02 ± 0.02, range: -0.09 to 0, $p<0.001$). The regional reduction in stiffness was concentred in the area inside the cone. The SSI values inside the cone were significant lower in the last exam (-0.15 ± 0.09, range: -0.42 to -0.01, $p<0.001$), while the SSI outside the cone presented minimum non-significant difference (0 ± 0.01, range: -0.04 to 0.01, $p=0.999$).

Conclusions: It has been observed through the SSI maps that the regional deterioration in stiffness was concerted inside the cone area, while only mild non-significant alteration was observed outside the diseased area.

Topics

- CXL pre-clinical, translational