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Paper Abstracts
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A new method to characterize scleral shape: tracking the radial evolution of decentration and toricity using Fourier analysis

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Purpose: To introduce a new method that captures the continuous radial and angular evolution of corneoscleral decentration and toricity from the corneal apex. The approach applies angular Fourier analysis to corneoscleral elevation profiles obtained from Scheimpflug imaging, enabling a continuous and orientation-aware description of anterior scleral geometry relevant for contact lens fitting.
Method: Thirty-three healthy eyes were imaged with the Pentacam HR using the Corneo-Scleral Profile (CSP) protocol. Only the anterior (front) surface was analyzed. Elevation maps were converted to polar coordinates and decomposed into angular Fourier harmonics (k = 0–5). The amplitude and phase (angle) of the first two harmonics were interpreted as indicators of surface decentration (k = 1) and toricity (k = 2), respectively. Both parameters were computed as a continuous function of radius (0–8 mm), allowing the detection of radial changes in both magnitude and angular orientation. This revealed a “moving” angular effect, where the direction of toricity and decentration shifts progressively with distance from the apex, a behavior not captured by traditional single-radius analyses.
Results: Both decentration (k = 1) and toricity (k = 2) amplitudes showed a marked increase beyond 6 mm, corresponding to the corneoscleral junction. Relative to the corneal region, decentration amplitude increased by approximately 180–220%, while toricity rose by about 60–80% in the scleral region. Additionally, the orientation of the toricity component changed continuously, with the toricity axis rotating by 40 ± 10° between 6 and 8 mm, revealing a radial evolution of anterior scleral toricity.
Conclusions: This method enables quantitative and angularly resolved characterization of corneoscleral shape from standard Scheimpflug imaging. By describing how decentration and toricity evolve in magnitude and orientation with radius, it introduces a new framework for characterizing the corneoscleral elevation map and supports personalized scleral lens design and ocular shape modeling.

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