A Comparison of Central Island Orthokeratology Defect Between Placido Disc Topography, Scheimpflug Tomography, and Fourier Projection Corneoscleral Profilometry

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Introduction

In myopic orthokeratology (MOK) the central cornea is flattened and lowered by a reverse geometry MOK lens. When there is insufficient compression of the central cornea leading to a focal area of higher tissue, this is referred to as a central island.

It is important to identify central islands as they can reduce visual acuity, depending on size and severity, as well as indicate potential complications such as punctate keratitis.

Three technologies exist to map the shape of a MOK treated cornea: Placido-disc corneal topography, Scheimpflug corneal tomography, and Fourier projection corneo-scleral profilometry. A direct comparison of these very different imaging technologies on the same eye and same day is rarely available but may reveal an advantage in one over another in detection of subtle MOK defects.

Methods

Translimbal MOK was designed for a -3.00D myope. At the six-month follow up he was imaged on the same day with all three corneal topography technologies – Placido-disc topography, Scheimpflug tomography, and Fourier projection profilometry – within minutes of each other.

The translimbal MOK lens demonstrated ideal fitting characteristics and a healthy corneal surface with no punctate staining, dystrophy, nodules, or other irregularities. (Figures 1,2)

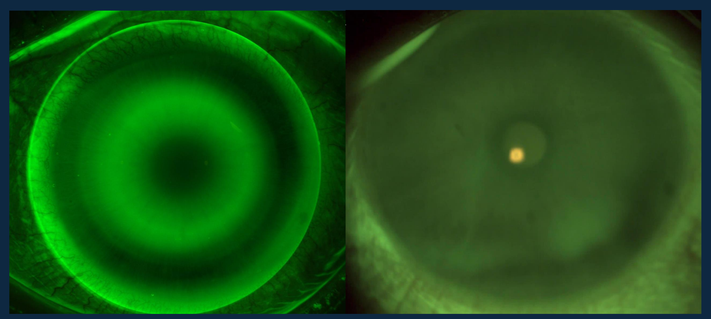

Fig. 1-2. Translimbal MOK (left) and fluorescein examination confirming healthy cornea without punctate staining or other irregularity (right)

Results

The quality of corneal imaging, repeatability, and reliability on all topography devices was confirmed to be very good, with intact tear film, good alignment, and good focus, ruling out any influence from artifacts. (Figure 3)

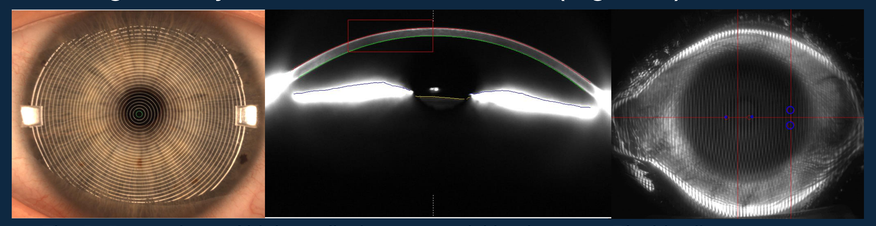

Fig. 3. Comparison of high-quality image acquisition between Placido-disc topography (left), Scheimpflug tomography (middle), and Fourier profilometry (right).

Topographical Axial maps were compared between the three imaging technologies at a mutual dioptric scale of 39D – 47D and a mutual difference (comparison) scale of -3.5D to +3.5D for the most direct and precise comparison between technologies. (Figures 4,5)

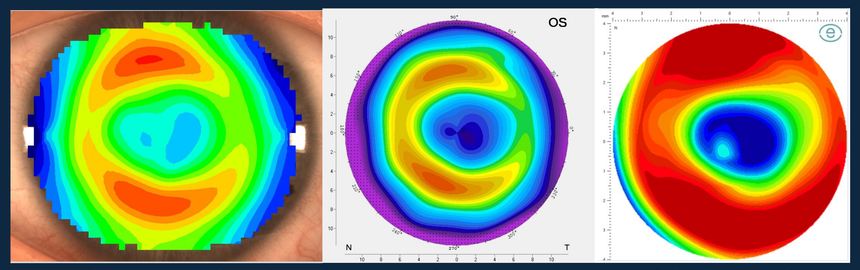

Fig. 4. Comparison of Axial maps between Placido-disc topography (left), Scheimpflug tomography (middle), and Fourier profilometry (right).

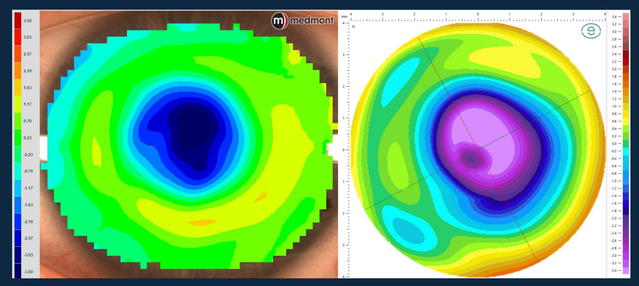

Fig. 5. Comparison of Axial difference, or subtraction, maps between Placido-disc topography (left) and Fourier profilometry (right). No pre-treatment Scheimpflug map was available for reference comparison.

Only Fourier projection profilometry displayed a well-defined area of focal elevation within the central corneal treatment zone, consistent with a small central island. Placido-disc topography and Scheimpflug tomography show very minimal topographical change in the same focal area.

Discussion

Interpolation is the estimation of unknown or inconsistent focal data within an area of known or consistent sequence of values. The advantage of interpolation in topography is that it will create a map with more uniformity, which may better summarize morphological characteristics of the cornea, as well as ignore potential untrue artifacts from tear film breakup, eyelash shadowing, tear meniscus, or epithelial staining. However, interpolation can make it difficult to detect the presence of important orthokeratology defects such as central islands, false central islands, and punctate epitheliopathy when they are truly present.

Placido disc topography projects concentric rings onto the cornea to measure curvature compared to a reference sphere. Focal irregularities are interpolated.

Scheimpflug tomography captures cross-sectional scans of the entire cornea to measure sagittal elevation of front and back cornea. Focal irregularities are also interpolated.

Fourier projection corneo-scleral profilometry projects two large grids onto the ocular surface and the degree of grid separation is compared to reference sphere to measure sagittal elevation. Uniquely, irregularities are not interpolated, and thus have a higher potential for displaying focal distortions, including true defects such as central islands, as well as untrue defects such as tear film dryness.

Conclusion

Fourier projection corneo-scleral profilometry may be a superior corneal imaging technology for the detection of subtle focal corneal shape defects from orthokeratology due to its precision of elevation data and the absence of data interpolation in profilometry maps.