

The Clinical Impact of Color LED Topographic Variability Analysis

An ongoing evaluation of large data sets to improve patients' outcomes.

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The introduction of any new method of corneal diagnostic measurement presents an opportunity for the evaluation of its routine clinical application in larger clinical numbers. As ophthalmologists become more comfortable with new techniques, refinements often make the technology more accessible to other clinicians. Corneal topography continues to evolve, as new techniques and features are introduced that make clinical imaging of the corneal shape and curvature more accurate. This technology is critical for many diagnoses such as keratoconus, planning surgical correction on the cornea, IOL calculations, and monitoring corneal treatments already performed. A new unit that uses color-coding shows promise.

PLACIDO AND COLOR-CODING METHODS

For years, clinicians have used Placido ring-based corneal topography systems, which benefit from instantaneous capture methods that reduce distortion due to eye movement during image acquisition. Tomography is used in corneal imaging with devices such as the Orbscan (Bausch + Lomb) and Scheimpflug-based technology such as the Pentacam Comprehensive Eye Scanner (Oculus) and Sirius (Costruzione Strumenti Oftalmici; not available in the United States). The tomography devices share the advantage of being able to provide posterior corneal curvature data and, in many cases, data on the anterior chamber, iris, and lens. These products, however, require clear media for proper imaging.

Alternatives to concentric mires Placido imaging, in the "reflection" topography device category, have been introduced that use color-coded, forward ray-tracing methods to enhance both radial and contour measurements. One example is the VU topographer (Vrije Universiteit Medical Center; not a commercial product)

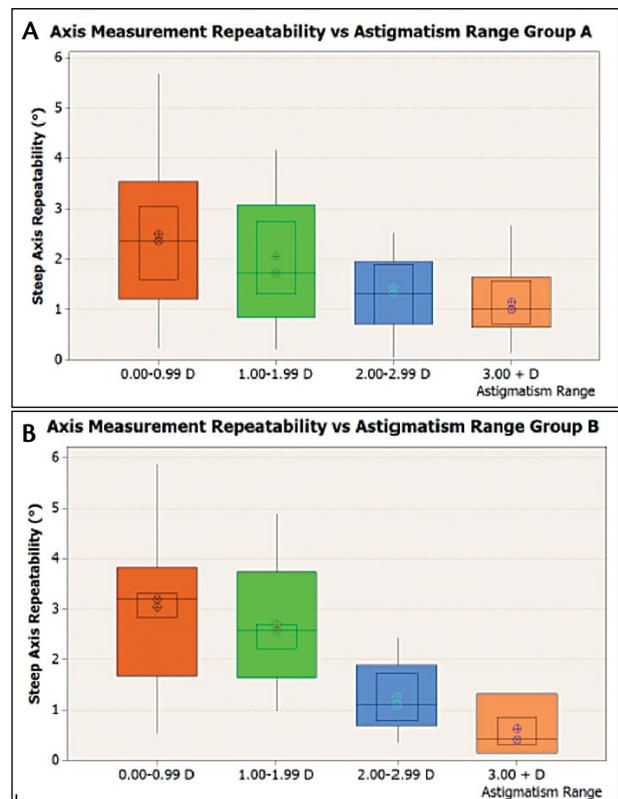


Figure 1. Steep axial measurement repeatability in the four subgroups of astigmatism range (A). Top, group A, normal patients, and bottom, group B, precataract patients (B).

described by Vos et al.¹ The color-coded, checkerboard-like pattern and software of the VU topographer were shown to be superior for measuring nonrotationally symmetric anterior corneal surface features.^{2,3}

The Cassini Color LED Corneal Analyzer (i-Optics) builds upon these principles by using a multicolored

asymmetric light-emitting diode (LED) design that employs more than 700 red, yellow, and green imaging points. The asymmetric panel design and multiple colors allow the software algorithm to account for the effects of spot blur that may be more difficult to interpret in a monochromatic light design. Essentially, the design creates a unique algorithm address for each colored spot relative to neighboring spots of different colors, as compared to a design that may use adjacent white lights.

The technology was introduced on a limited basis in early 2013⁴ and was subsequently launched for wider clinical application at the 2013 annual meeting of the European Society of Cataract & Refractive Surgeons. Thereafter, we reported our use of the system and its software enhancements to evaluate case studies of central corneal dystrophy and keratoconus.^{5,6}

CLINICAL EXPERIENCE USING COLOR LED

We have generated data from the routine clinical use of the Cassini system to study its precision and variability in large data sets. We recently performed a prospective observational analysis of 350 total eyes by using the device to perform anterior corneal measurements on a group of healthy patients (control group A, n = 175 eyes) and a group of precataract patients

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(group B, n = 175 eyes). All eyes had no current or prior history of surgery or ocular pathology other than cataract. The analysis included the repeatability of both the magnitude of astigmatism and the steep meridian axis. We obtained informed consent, and institutional ethics committee oversight was used during the research. We used statistical software to include paired analysis *t*-tests and analysis of variance.

On average, the control group A demonstrated with-the-rule astigmatism compared with the older precataract group B, which had, on average, against-the-rule astigmatism. Analyses were divided into groups of astigmatism from 0 to 0.99 D, 1.00 to 1.99 D, 2.00 to 2.99 D, and greater than or equal to 3.00 D. Repeatability of the magnitude of astigmatism averaged from 0.25 to 0.59 D in group A and from 0.35 to 0.61 D in group B. Average

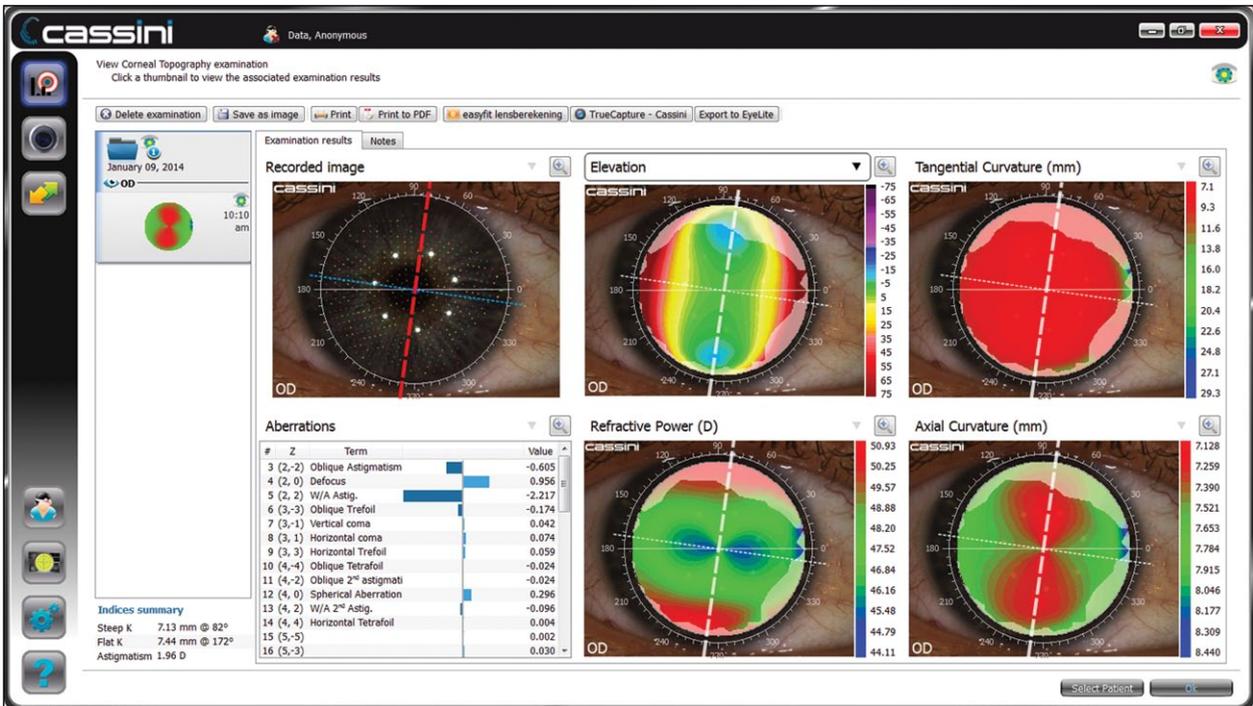


Figure 2. Cassini corneal shape analysis is customizable. Shown here are the axial, elevation, tangential, and refractive power maps and aberrations table.

axis repeatability (Figure 1) was from 2.49° (astigmatism 0-0.99 D) to 1.14° (astigmatism ≥ 3.00 D) in group A and from 3.03° (astigmatism 0-0.99 D) to 0.62° (astigmatism ≥ 3.00 D) in group B.

CONCLUSION

A key clinical takeaway point of our research was that the steep axis of astigmatism appeared to shift on average from with the rule to against the rule with increasing age and cataract development. The Cassini demonstrated high specificity in measuring corneal astigmatism, with magnitude repeatability under 0.60 D and axial repeatability of less than 3°. Axial measurement repeatability improved in eyes with higher amounts of astigmatism. These characteristics suggest exciting opportunities to improve the patient-specific data acquired prior to planning surgical correction.

We look forward to further using Cassini color LED corneal analysis and its continued integration into surgical planning (Figure 2). For the past few years, we have used reflection topography devices such as a classic Placido-derived topographer and the newer Cassini topography side by side with Scheimpflug tomography and anterior segment optical coherence tomography. This approach using multiple technologies in order to reduce the possibility of examination bias is important when critical diagnostic decisions

are being made and/or postoperative treatment effect is evaluated. ■

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