Algorithm for Correcting the Keratometric Estimation Error in Normal Eyes

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ABSTRACT

Purpose. To obtain an accurate algorithm for calculating the keratometric index that minimizes the errors in the calculation of corneal power assuming only a single corneal surface in the range of corneal curvatures of the normal population.

Methods. Corneal power was calculated by using the classical keratometric index and also by using the Gaussian equation. Differences between types of calculation of corneal power were determined and modeled by regression analysis.

Results. We proposed two options for the selection of the most appropriate keratometric index (nk) value for each specific case. First was the use of specific linear equations (depending on the ratio of the anterior to the posterior curvature, k ratio) according to the value of the central radius of curvature of the anterior corneal surface (r1c) in 0.1 mm steps and the theoretical eye model considered. The second was the use of a general simplified equation only requiring r1c (Gullstrand eye model, nk = −0.0064286r1c + 1.37688; Le Grand eye model, nk = −0.0063804r1c + 1.37806).

Conclusions. The generalization of the keratometric index (nk) value is not an appropriate approximation for the estimation of the corneal power and it can lead to significant errors. We proposed a new algorithm depending on r1c, with a maximal associated error in the calculation of the corneal power of 0.5 D and without requiring knowledge of the posterior corneal curvature.

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Key Words: corneal power, keratometry, keratometric refractive index, Gaussian corneal power

In clinical practice, total corneal power is usually calculated considering only the radius of curvature of the anterior corneal surface measured by means of a keratometer or a topography system. Two main factors account for this simplification. One is the assumption of a minimal contribution of the posterior corneal surface to the ocular refractive power because of the small difference in refractive index at this surface. The other is the technological limitations for characterizing the curvature of the posterior corneal surface that were present until the last decades of the past century. In this context, the concept of keratometric index (nk) was developed assuming a corneal model consisting of a single spherical surface with the radius of curvature of the epithelial surface and a constructed index of refraction, nk, which provides a correction for this simplified model. Different values have been defined for nk depending on the keratometer or topographer manufacturer, going from the classical value of 1.3375 (Haag-Strait, Bausch and Lomb) to values of 1.336 (American Optical), 1.3333, or 1.332 (Zeiss). The reason for using one or another value of nk is not always clear. For example, the use of the classical value of 1.3375 was only proposed for convenience rather than for optical significance, because it provided an agreement between a specific value of the anterior radius of curvature and the total corneal power (7.5 mm and 45.0 D).1,2 Other values of nk have been derived from schematic eye models, such as the value of 1.3315, which was derived from the Gullstrand schematic3 eye and recommended by Olsen.1

Differences between the corneal power calculated by using nk and that calculated considering both corneal surfaces can occur. These differences have been widely studied in the normal population (eyes without pathology and without previous ocular surgery).