Look-up table of quadrics applied to corneal topography
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Summary
Present a new look-up table method to convert acquired corneal data from reflected Placido rings to curvature radii. The technique avoids extrapolating corneal data and overcomes the difficulty with the lack of symmetry of projected rings and provides a better description of the corneal morphology.

Introduction
The information in obtaining a corneal topography using a commercial device usually is hidden, in spite of being of interest for researchers. In previous works \cite{1,2}, the authors detailed the algorithms and procedures to obtain the curvature data of cornea. Radial distances from Placido rings were related to the correspondent local curvature radii through a set of calibration curves (look-up table method). If the method was able to distinguish and classify reflected rings, with a Cartesian grid, the CCD array of the camera.

 RESULTS

Figure 1 and Table 1 show results for the fitting of ring $l=16$. For this ring, the coefficients are $a=0.78 \pm 0.02$, $b=1.50 \pm 0.08$, $c=-0.35 \pm 0.04$, $d=-1.14 \pm 0.01$, and $e=2.07 \pm 0.03$, respectively.

Discussion
Equation (1) introduces a dependence of radial distance with the ring's label. Moreover, it is a unique calibration equation, alternatively to that set of curves in \cite{2}. They considered three variables, the independent variables $L$ corresponding to the ring's label, $C$ the curvature radius, and $R$, the radial distance of each ring, which was set as the radius obtained from least square fitting to a circle. The radial distance of each reflected ring on a surface depends both on the curvature radius of the surface and the ring's label as $R=a+bLC$. Coefficients $a$ and $b$ could be obtained through least square fitting of computed radial distances. In order to compute the curvature radius $R_c(x,y)$ at each pixel at a distance $R_x,y$ from center, and being part of a reflected ring $L$, we have

$$C(x,y) = \begin{cases} R(x,y) & \text{if } \text{Ring}, \end{cases}$$

where $v_i = (x_i, y_i, C_i)$ are row vectors containing the coordinates of each ring or edge for each calibration surface of curvature radius is the transpose of $v_i$, $D_i$ are $3 \times 3$ matrices, $E_i$ are $3$-dimensional row vectors and $F_i$ are scalar constants. Expression (2) provides a calibration equation for each ring as

$$C = \begin{pmatrix} x & y & C \end{pmatrix}^T$$

Curvature radii and $(x, y)$ coordinates of data for each ring are least-squares fitting to (3), thus providing a look-up table of quadrics. The method overcomes the interpolation of Cartesian data so it improves the morphological description of corneal surface.

References