Keratometer

A **keratometer**, also known as a **ophthalmometer**, is a diagnostic instrument for measuring the curvature of the anterior surface of the cornea, particularly for assessing the extent and axis of astigmatism. It was invented by the German physiologist Hermann von Helmholtz in 1880, (although an earlier model was developed in 1796 by Jesse Ramsden and Everard Home.

A keratometer uses the relationship between object size (O), image size (I), the distance between the reflective surface and the object (d), and the radius of the reflective surface (R). If three of these variables are known (or fixed), the fourth can be calculated using the formula

R = 2dI/O

There are two distinct variants of determining R; Javal-Schiotz type keratometers have a fixed image size and are typically 'two position', whereas Bausch and Lomb type keratometers have a fixed object size and are usually 'one position'.

Javal-Schiotz Principles

The Javal-Schiotz keratometer is a two position instrument which uses a fixed image and doubling size and adjustable object size to determine the radius of curvature of the reflective surface. It uses two self illuminated mires (the object), one a red square, the other a green staircase design, which are held on a circumferential track in order to maintain a fixed distance from the eye. The object size is adjusted by maneuvering the mires along this track, changing the distance between them. The reflected image is doubled through a Wollaston prism, which then allows either side of the doubled image to be aligned, and any eye movement to cancel out as both images move with the same magnitude and direction, the relative separation remaining constant. A Wollaston prism uses the polarising property of light in order to split a single image into two separate, visually identical but oppositely polarised images. Once the mires are focused, the only variable remaining is object size, which is calibrated to a measurement of reflective surface radius (and sometimes dioptric power using an estimation of refractive index). This gives the curvature of the meridian along the path of the circumferential arms, the axis of which can be read from a scale around which the arms rotate. The axis can be manipulated to any axis, giving a distinct advantage over a single position keratometer in cases of irregular astigmatism.

In order to get repeatable, accurate measurements, it is important that the instrument stays focused. It uses the Scheiner principle, common in autofocus devices, in which the converging reflected rays coming towards the eyepiece are viewed through (at least) two separate symmetrical apertures. As the rays passing through each aperture will have the same vergence, they should, meet at the same point. By adjusting the distance between the object and the reflective surface, the vergence of the rays can be altered until a crisp focus is obtained, correlating to the fixed focal point of the telescopic eyepiece.

Bausch and Lomb principles

The Bausch and Lomb keratometer is a one position keratometer that gives readings in dioptric form. It differs from the Javal-Schiotz in that object size is fixed, image size is the manipulable variable. The reflected rays are passed through a Scheiner disc with 4 apertures – two of which are used for the focusing of the mires at the fixed telescope focal distance, the other two for dual prism doubling. The instrument is based on the Helmholtz design which has two maneuverable prisms aligned vertically and horizontally. This creates two adjustable images in addition to the original image, one above and one to the left. By adjusting the distance between the eyepiece and the prism, the effective power of these prisms can be altered. As the distance is decreased, the effective prismatic power decreases. This decreases the image size along the respective prism alignment, moving the duplicate image closer to the original. An increase in the eyepiece to prism distance leads to an increase in prismatic shift. As there are two prisms, each aligned perpendicular to the other, the major and minor axis powers can be measured independently without adjusting the orientation of the instrument.

In converting the measurements obtained from the corneal surface into a dioptric value, the B&L keratometer uses the general lens formula (n'-n)/R and assumes an n' of 1.3375 (compared to the actual corneal refractive index of n'=1.376). This is a fictional value, which includes an allowance for the small, yet significant, negative power of the posterior corneal surface. This allows for a readout in both refractive power (dioptres) and radius of curvature (millimeters).

References

- Javal L, Schiötz H. *Un opthalmomètre pratique*. Annales d'oculistique, Paris, 1881, 86: 5-21.

External links

- Keratometers in the market [1]

References

[1] http://www.optivision2020.com/keratometer.html

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