KERATOMETRY

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Sight For All

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Keratometry

Outline

– History
– Types of keratometers
– Advantages
– Limitations
– Procedure
– Recording
– Interpretation
KERATOMETER

• Most widely used instrument for measuring the curvature of the anterior corneal surface
HISTORY

- Early attempts in measuring the cornea included use of rulers and compasses.
- Principle of keratometry treats the cornea as a spherical convex mirror with the image size formed varying with the curvature of the cornea:
  \[ r = 2u \frac{I}{O} \]
HISTORY

• Ramsden (1796) used a telescope to magnify the image of mires which included a doubling device
• Helmholtz (1854) added a doubling device made of glass plates
• Javal and Schiøtz (1881) made improvements by using mires that were adjustable in terms of size
• With minor alterations we have the Haag-Streit ophthalmometer and the Riechert keratometer (1932)
ADVANTAGES

• Easy to use
• Inexpensive
• Relatively accurate
• Reproducible
LIMITATIONS

• Assumption that cornea is symmetrically spherical or spherocylindrical
• Measures small area of the central cornea (3-4mm diameter)
• Less accurate measuring irregular surfaces: very flat or steep cornea, irregular astigmatism
• Does not quantify irregular astigmatism
• One-position instruments assume regular astigmatism
• Approximate focal point and refractive index used in calculation
• The use of paraxial optics to calculate surface power
• Limitations in detecting peripheral or posterior keratoconus
Types of Keratometers

Hand-held autokeratometer

Humphrey autokeratometer

KERATOMETER (B&L TYPE)

Javal-Schiotz Keratometer
Bausch and Lomb
One-position, variable, double Keratometer

• Gives readings in dioptric form.
• Object size is fixed
• Image doubling size is the variable
• Can measure both principal meridians without having to reposition the instrument
• Principle meridians are assumed to be at right angles to each other
Two-position, fixed, double Keratometer

- Require rotation about the axis to measure each other principal meridians
- Fixed doubling image size
- Object size adjusted
- Only measures one meridian at a time
<table>
<thead>
<tr>
<th>B&amp;L one-position Keratometer</th>
<th>Javal-Schiotz two-position Keratometer</th>
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<tbody>
<tr>
<td><strong>Advantages</strong></td>
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<tr>
<td>• Quick to use</td>
<td>• Used for patients with irregular astigmatism.</td>
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<td>• If it’s a telecentric design no focussing errors and therefore no inaccuracies (expensive, not common)</td>
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<td>• More accurate as longer working distance</td>
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<td><strong>Disadvantages</strong></td>
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<tr>
<td>• Assumes meridians are at 90 degrees</td>
<td>• Uses radii scale – if falls at extreme ends of arc, it becomes non-linear - inaccuracy</td>
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<td>• Shorter working distances – measurement errors</td>
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<td>• Vertical and horizontal mires imaged at the same time</td>
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Procedures

• Correctly calibrated device
• Correct measuring technique
Calibration

- Measure the radius of one/many spherical objects of known radius of curvature
- Graph readings on device against actual radius
- Mean of 2 curves = calibration
Eyepiece Adjustment

- Rotate eyepiece counter clock-wise to reset calibration
- Rotate eyepiece clock-wise until crosshairs are sharp
Instrument Alignment

- Device lines up with patient’s outer canthus
- Center the reflections of the mires as close to the centre of the cornea as possible
- Patient focus onto the fixation light, or the reflection of their own eye
- Complete the alignment by centering the focus mire, the corner circle on the crosshairs
Focusing the Mires

• When taking measurements, maintain a single image

• Keep horizontal portion single when taking horizontal measurements

• Keep vertical portion single when taking vertical measurements.
Axis Measurement

- Tube should be rotated until the left-mire and focusing-mire plus signs are perfectly in line.
CURVATURE MEASUREMENT

• Readings should be taken immediately after completion of a blink
• Using the left measuring drum, the plus signs should be superimposed to measure the curvature in the most horizontal meridian
• For the more vertical meridian, the right measuring drum is used instead to superimpose the minus signs
Recoding

1. Record radius of curvature (mm) and axis of the most horizontal meridian first

2. Record radius and orientation of vertical meridian

   e.g. \[ \text{R 7.75 @ 175 / 7.60 @ 85} \]
   \[ \text{L 7.70 @ 180 / 7.60 @ 90} \]

   If mires are distorted, this must be recorded
Conversion to Corneal Power

Radius of curvature can be converted into corneal power using equation:

$$K = \frac{(n - 1)}{r}$$

- $K$ = corneal power (D)
- $n$ = refractive index of cornea = 1.3375
- $r$ = radius of curvature of anterior corneal surface (m)

refractive index of the cornea is actually 1.376 but we use $n = 1.3375$ to compensate for the negative power of the posterior corneal surface

$$K = \frac{0.3375}{r}$$

or for $r$ in mm $K = \frac{337.5}{r}$

convex-concave lens
Recording

- Difference between two powers equals approximate total corneal astigmatism
- Flatter meridian corresponds to corneal minus cylinder axis

E.g. OD: 42.00 @ 175 / 43.75 @ 85, -1.75 x 175, mires distorted
    OS: 43.50 @ 180 / 44.25 @ 90, -0.75 x 180, mires clear
Interpretation

Normal values
Anterior radius of curvature: 7.25-8.50 mm
  - myopes have smaller radii, hyperopes have larger radii

Corneal power: 43.25-44.50 D
  - can indicate whether ametropia is refractive or axial
  e.g. a myope with normal corneal power probably has axial myopia
Interpretation

Normal values

• With the Rule astigmatism in younger patients
• In patients over 40, shift towards Against the Rule astigmatism
• Corneal astigmatism less than 2.00D
• Mires distorted and/or unusually steep readings can be indicative of keratoconus or irregular astigmatism
Uses of Keratometer

- Contact lens practice- base curve selection, overkeratometry
- Assess extent and axis of astigmatism
- Monitoring distortion of corneal surface: keratoconus, oedema, C/L wear, surgery
- Determine whether ametropia is of refractive or axial etiology
- Provides quantitative description of central corneal curvature
- Calculate IOL power


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