Interperatation of pentacam

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Cornea & Anterior Segment Service

Shiraz university of Medical science

Khalili hospital
Quality of vision

- Improving quality of vision
- Improving quality of life
Methods of Image Formation:

- **Reflection technique:** placido disk
  (Indirect measurement of the corneal surface)

- **Projection technique:**
  - Slit image of the cornea.
    - Two scanning vertical slits
    - Rotating slit (based on the Scheimpflug imaging principle)
Placido derived curvature maps will often miss early keratoconus and frequently miss diagnose a “normal” cornea with a off-centered apex as keratoconus.

Elevation maps are a more reliable method to detect early keratoconus.

The elevation maps are more accurate than curvature maps in evaluating both surfaces of the cornea. They are less affected by tear film disturbance and use of contact lenses.
suspicous elevation
Best Fit (sphere)  
Calculation Diameter = Fitting zone
Elevation Map & references bodies

There are three selectable reference bodies:

- **Toric Ellipsoid**
  - matches perfect to astigmatic corneas

- **Ellipsoid**
  - matches optimal to the true shape of the cornea

- **Best Fit Sphere**
  - Comparable to Orbscan
  - **Float** representation: same as Orbscan
  - **Fixed**: reference body is fixed at the apex
P.S. In case of any irregularity or suspicious values on elevation maps with the BFS, it is recommended to see the elevation maps with Toric Ellipsoid float reference body; when the irregularities are due to corneal astigmatism, they will vanish, otherwise they stay when they are due to real corneal surface irregularity. The toric ellipsoid option eliminates the effect of corneal astigmatic slope on the elevation maps. This is important especially for the back surface where the subclinical keratoconus begins.
Astigmatism when displayed in elevations

- Steep meridian
- Flat meridian
Mostly used to display corneal superficial powers

1- **Cool colors**
(violets and blues): low power, flat curvatures, low diopters

2- **Greens and yellows**: normal corneas

3- **Warm or hot colors**
(oranges and reds): higher powers, steep curvatures, higher diopter
Intuitive Spectral Directions

- Although there are no universally standardized colors, the spectral direction (from blue to red) is always organized in a definite and intuitive way.

  - **Blue** = low, flat, deep, thick, or aberrated
  - **Red** = high, steep, sharp, shallow, thin, or focused.
Basic:

- The Pentacam is a rotating Scheimpflug Camera

- The Pentacam has two integrated Cameras
  - one camera to detect size and orientation of the pupil & control fixation
  - second camera is mounted on the rotating wheel to take pictures of cornea and anterior segment
Problem of a normal Camera:
limited depth of focus

The Scheimpflug law says: To get a higher depth of focus, move the three planes, provided that the **picture plane**, the **objective plane** and the **film plane** has to cut each other in one line or one point of intersection.
Schematic course of a scan
Scheimpflug Example

Greater depth of field
Pentacam, the comprehensive analyzer

Scheimpflug Image
  + 3D Anterior Chamber Analyzer
  + Pachymetry Map
  + Topography Maps (ant. & post.)
  + Elevation Maps (ant. & post.)
  + Anterior Chamber Depth Map
  + Cataract Analyzer
  + Holladay Report
  + Tomography

= Pentacam

With only 1 measurement in less than 2 seconds
Clinical Applications

*The Pentacam is the optimum analyser for:*

- Corneal refractive surgeons
- Cataract surgeons
- Glaucoma screening
Refractive Surgeon

R/O KCN
Phakic iol
Keratoconus & Ectatic Corneal Disorders

- Keratoconus is still a Contraindication for Refractive Surgery procedures
Preoperative topographic screening prior to keratorefractive surgery has largely focused on keratoconus.

8% of myopes presenting for refractive surgery have suggestive topographic pattern like KCN.
Azar and Lu reported an Massachusetts Eye and Ear Infirmary (MEEI) keratoconus scoring system, which combines,

- history,
- examination,
- topographic indices

to establish criteria for distinguishing

- healthy control subjects,
- keratoconus suspects,
- early keratoconus,
- advanced keratoconus,
classification Based on Clinical Examination and Topographic Indices

- If corneal hydrops is present on examination or obtained from history, 2 points are assigned; otherwise, 0 points are assigned.

- If at least two findings on examination (Fleischer ring, Vogt's striae, Munson's sign, scarring) or history (atopy, Down's syndrome, family history) are present, 2 points are assigned; if fewer than two findings are present, 0 points are assigned.
**classification Based on Clinical Examination and Topographic Indices**

- If asymmetric anterior central corneal power between right and left eyes is 1.90 or less, 0 points are assigned to both eyes; if asymmetry greater than 1.90 is present, the eye with the higher corneal power receives 1 point and the other eye receives 0 points.

- Anterior central corneal power \( K < 47.2 \) 0, 47.2 to 48.7 D or \( >48.7 \) D is assigned 0, 1, or 2 points, respectively.

- Inferior-superior asymmetry (1-5 value) \( < 1.4 \) D, 1.4 to 1.9 D, or \( > 1.9 \) D is assigned 0, 1, or 2 points, respectively.
classification Based on Clinical Examination and Topographic Indices

- Total scores of:
  - 0, normal cornea
  - 1 to 3, keratoconus suspect
  - 4 or 5, early keratoconus
  - 6 to 9, advanced keratoconus,
KCN clinical classification

1. Clinical keratoconus
2. Subclinical keratoconus
3. Keratoconus suspect
Clinical keratoconus

- Clinical slit-lamp signs of keratoconus
- Scissoring of retinoscopic reflex with dilated pupil
- (+) topographic pattern
Clinical keratoconus

- Clinical slit-lamp signs of keratoconus
- Scissoring of retinoscopic reflex with dilated pupil
- (+) topographic pattern
Subclinical keratoconus

- No clinical slit-lamp findings
- Scissoring of retinoscopic reflex with fully dilated pupil
- (+) topographic pattern
Keratoconus suspect

1. No clinical slit-lamp findings
2. No scissoring of retinoscopic reflex with dilated pupil
3. (+) topographic pattern
Screening before refractive surgery

- Firstly: the anterior and posterior elevation
- Secondly: look at the pachymetry and thickness distribution, and pay attention to the off-center distribution of corneal thickness
- Finally: completely scan the curvature and the symmetry of both eyes.
Cornea Front

Rf: 8.03 mm  
Rs: 7.74 mm  
Rm: 7.88 mm  
Qs: OK (flat)  
Axis: 8.1°  
Q-val.: -0.51  
Q-per: 8.26 mm  
Rmin: 7.66 mm  
K1: 42.0 D  
K2: 43.6 D  
Km: 42.8 D  
Astig: 1.6 D

Cornea Back

Rf: 6.68 mm  
Rs: 6.29 mm  
Rm: 6.48 mm  
Qs: OK (flat)  
Axis: 2.3°  
Q-val.: 0.4 D  
K1: -6.0 D  
K2: -6.4 D  
Km: -6.2 D  
Astig: 0.4 D
value is \(< -0.5\) (as an absolute value). It is borderline when it falls between \(-0.5\) and \(-0.55\). If the value is \(> -0.55\) (as an absolute value), we should hesitate a lot before proceeding to the standard Lasik treatment. The most important sector is the 6 mm or 20° sector.
\[ Q = \frac{b^2}{a^2} - 1 \]

- **Aspheric**: 
  - **Prolate**: \( Q = -0.5 \)
  - **Oblate**: \( Q = +0.5 \)

- **Spherical**: \( Q = \text{zero} \)
Q-value

spherical

aspheric
<table>
<thead>
<tr>
<th>Asphericity (Q)</th>
<th>Shape</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0</td>
<td>Oblate</td>
<td>Peripheral steepening</td>
<td>Radial keratotomy</td>
</tr>
<tr>
<td>0</td>
<td>Spherical</td>
<td>Uniform curvature</td>
<td>Steel calibration ball</td>
</tr>
<tr>
<td>&lt;0</td>
<td>Prolate</td>
<td>Peripheral flattening</td>
<td></td>
</tr>
<tr>
<td>-0.26</td>
<td>Prolate</td>
<td>Mild peripheral flattening</td>
<td>Normal cornea</td>
</tr>
<tr>
<td>&lt; -0.26</td>
<td>Prolate</td>
<td>Marked peripheral flattening</td>
<td>Keratoconus</td>
</tr>
</tbody>
</table>
Proposed Screening Parameters

- **Settings**: BFS, fitted in float, 8 mm diameter

- **Anterior** Elevation differences $< +12$ microns are considered normal

- **Anterior** Elevation differences $> +15$ microns are indicative of keratoconus

- **Anterior** Elevation differences between $+12 - 15$ microns are suspicious

- Similar numbers (*but about 5 micron higher*) apply to Posterior Elevation, but our experience is limited
P.S. 1: Be careful when any value of the central 4 mm of the elevation maps is more than +15 μ for the anterior surface, and more than +20 μ for the posterior surface.
P.S. 2: Be careful when the "back-front" difference is more than +5 μ at the same point.
P.S. 3: Be careful when there is an isolated island on either surface.
Delta $\Delta$(local), posterior elevation to anterior elevation $+7$ to $+10$ micron might be suspicious.
What should I check by looking at the elevation maps?

- Shape
- Parameter
What should I check by looking at the Pachymetry maps?

- **Shape**
- **Parameter**
- **Thinnest location coordinates**
- **Thickness indices**
The standard thickness Map
Shape
Parameter
The relation between the apex of the cornea and the center of the pupil: It is important in the issue of "decentration" or "offset pupil". The relation between the apex of the cornea and the thinnest location: This relationship could be according to thickness or to coordinates.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pachy:</th>
<th>x[mm]</th>
<th>y[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil Center:</td>
<td>512 μm</td>
<td>-0.03</td>
<td>-0.06</td>
</tr>
<tr>
<td>Pachy Apex:</td>
<td>512 μm</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Thinnest Locat.:</td>
<td>495 μm</td>
<td>+0.44</td>
<td>-1.31</td>
</tr>
</tbody>
</table>
Coordinates

<table>
<thead>
<tr>
<th>Parameter</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil Center:</td>
<td>+</td>
<td>577 μm</td>
</tr>
<tr>
<td>Pachy Apex:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thinnest Locat.:</td>
<td>O</td>
<td>577 μm</td>
</tr>
<tr>
<td>K Max. (Front):</td>
<td></td>
<td>41.0 D</td>
</tr>
</tbody>
</table>

**Pachy:**

- x[mm]: -0.22
- y[mm]: +0.07

- x[mm]: 0.00
- y[mm]: 0.00

- x[mm]: -0.29
- y[mm]: 0.00

- x[mm]: -0.07
- y[mm]: +1.45
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-val: (8mm)</td>
<td>-0.42</td>
</tr>
<tr>
<td>Rper:</td>
<td>6.82 mm</td>
</tr>
<tr>
<td>Rmin:</td>
<td>6.14 mm</td>
</tr>
<tr>
<td>Pupil Center:</td>
<td>+546 ( \mu m )</td>
</tr>
<tr>
<td>Pachy Apex:</td>
<td>544 ( \mu m )</td>
</tr>
<tr>
<td>Thinnest Locat.:</td>
<td>542 ( \mu m )</td>
</tr>
<tr>
<td>K Max. (Front):</td>
<td>44.0 D</td>
</tr>
<tr>
<td>Cornea Volume:</td>
<td>60.2 mm³</td>
</tr>
<tr>
<td>Chamber Volume:</td>
<td>196 mm³</td>
</tr>
<tr>
<td>x[mm]</td>
<td>+0.07</td>
</tr>
<tr>
<td>y[mm]</td>
<td>+0.18</td>
</tr>
<tr>
<td>x[mm]</td>
<td>0.00</td>
</tr>
<tr>
<td>y[mm]</td>
<td>0.00</td>
</tr>
<tr>
<td>x[mm]</td>
<td>-0.50</td>
</tr>
<tr>
<td>y[mm]</td>
<td>-0.25</td>
</tr>
<tr>
<td>Angle:</td>
<td>24.7°</td>
</tr>
<tr>
<td>KPD:</td>
<td>+1.1 D</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Q-val: (8mm)</td>
<td>-1.11</td>
</tr>
<tr>
<td>Rper:</td>
<td>7.06 mm</td>
</tr>
<tr>
<td>Rmin:</td>
<td>4.48 mm</td>
</tr>
<tr>
<td>Pupil Center:</td>
<td>$\mu m + 480 \mu m$</td>
</tr>
<tr>
<td></td>
<td>x[mm]: -0.24 y[mm]: +0.29</td>
</tr>
<tr>
<td>Pachy Apex:</td>
<td>474 $\mu m$</td>
</tr>
<tr>
<td>Thinnest Locat.:</td>
<td>$\mu m - 462 \mu m$</td>
</tr>
<tr>
<td></td>
<td>x[mm]: -0.70 y[mm]: -0.63</td>
</tr>
<tr>
<td>K Max. (Front):</td>
<td>52.8 D</td>
</tr>
<tr>
<td></td>
<td>x[mm]: +0.35 y[mm]: -0.49</td>
</tr>
<tr>
<td>Cornea Volume:</td>
<td>54.5 mm$^3$</td>
</tr>
<tr>
<td>KPD:</td>
<td>+1.6 D</td>
</tr>
</tbody>
</table>
Pachymetric Map

- **CTSP**: Corneal Thickness Spatial Profile
- **PTI**: Percentage Thickness Increase

The ‘**progression index**’ is calculated as the progression value at the different rings. The best cut off point is **1.35**

These parameters allow for the differentiation of a **normal thin cornea** versus **ectasia**.
**Application:**
- Keratoconus detection and quantification based on anterior corneal data.
- Corneal thickness progression provides information about corneal stability.
- Screening for Lasik candidates.

**Index of Surface Variance:** Value of curvature variation from the mean curvature.

**Index of Vertical Asymmetry:** Value of curvature asymmetry comparison of the upper and lower area.

**Keratoconus Index:**
- Increases with severity of keratoconus.
- Inter Keratoconus Index

**Graphs and Charts:**
- Corneal thickness data with progression analysis.
- Topographical mapping showing corneal thickness variations.

**Indices in 8mm zone:**
- ISV: 13
- IHA: 3.3
- NA: 0.11
- IHD: 0.0085
- K1: 1.05
- RMirc: 7.21
- CRI: 1.01
- ABR: 0.0
Compare the thinnest location between the examined cornea and its fellow, the difference should be no more than 30 microns.

\[ \text{the thickness at the apex with} \]
\[ \text{the thickness at the thinnest location}. \text{ The difference} \]
\[ \text{should be no more than 10 \( \mu \) and not increasing with} \]
\[ \text{follow up.} \]

The relationship according to coordinates

When the value exceeds -500 \( \mu \), it is a risk factor, especially when the difference is increasing with follow up at one to two years intervals. When this value exceeds -1000 \( \mu \), it is an important sign of an advanced keratoconus.

Look for the thickness on the 4 mm circle: There should be no more than 30 \( \mu \) difference between the superior and inferior points (we will call this from now as superior-inferior difference).
Optional Modules

Holladay Report and EKR Detail Report
- ultimate overview and EKR's for advanced IOL calculation

Belin/Ambrosio
- unique tool for early keratoconus detection

Contact Lens Fitting
- simulation program for RGP lenses incl. a huge pre-programmed data base
Belin / Ambrósio Enhanced Ectasia Display: BAD

- During the ASCRS in Chicago, Oculus has presented unique software feature of the Pentacam

- The goal of BAD II is to combine elevation and pachymetric corneal evaluation in one display.

- This allows the physician to quickly and effectively screen patients for ectatic disease.
**Enhanced Best fit sphere**

Excluding 3.5mm circular area around thinnest pachy location!

Location of thinnest pachy
Keratoconus fit with Best Fit Sphere \hspace{1cm} \textit{VS} \hspace{1cm} Keratoconus fit with New Reference Shape

Normal fit with Best Fit Sphere \hspace{1cm} \textit{VS} \hspace{1cm} Normal fit with new Reference Shape
BFS vs Enhanced BFS in Normals

Figure 9. In the normal cornea, there is little change in relative elevation, or the appearance of the elevation map when comparing the BFS (left) to the enhanced BFS (right).
Figure 10. In the abnormal cornea, there is significant change in relative elevation, and the appearance of the elevation map when comparing the BFS (left) to the enhanced BFS (right). The area of the cone is more easily seen on the exclusion map (right).
distance in vector notation

progression index

“traffic light”
green = ok
yellow = suscep.
red = abnormal
BAD II

- It reports five new terms (*D values for* standard deviation from the mean) representing the front surface (*Df*), back surface (*Db*), *pachymetric* progression (*Dp*), *thinnest point* (*Dt*), and thinnest point displacement (*Dy*).

- **A sixth term (D) is the final overall map reading** taking each of the five parameters into account.
Deviation Indices for detection of keratoconus and ectasia susceptibility:

\[ D = \text{Standard deviation} \quad 1 = \text{average population.} \]

\[
\begin{align*}
\leq 1.6 \text{ SD} & = \text{White} \\
\leq 2.6 \text{ SD} & = \text{Yellow} \\
\geq 2.6 \text{ SD} & = \text{red}
\end{align*}
\]

\[ D = \text{Total deviation} \quad (\text{over all score of the values } D_f, D_b, D_p, D_t \text{ and } D_y) \]
### Table 3.1: The normal, suspected and abnormal findings in corneal topography

<table>
<thead>
<tr>
<th>Quality specification (QS)</th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-readings:</td>
<td>look at flat K for myopic treatment</td>
<td>look at steep K for hyperopic treatment</td>
<td>&gt;48</td>
</tr>
</tbody>
</table>

### Corneal astigmatism

<table>
<thead>
<tr>
<th>Average Q-value Topometric map (vertical and inferior Q-values)</th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to -1</td>
<td>0.5 to -0.55</td>
<td>&gt;-0.55</td>
<td></td>
</tr>
</tbody>
</table>

### Thinnest location

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;500</td>
<td>470 – 500</td>
<td>&lt;470</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Difference with pachy apex thickness</th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5μ</td>
<td>5 – 10μ</td>
<td>&gt;10μ</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Co-ordinates</th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500μ</td>
<td>500 – 1000μ</td>
<td>&gt;1000μ</td>
<td></td>
</tr>
<tr>
<td>Pupil center co-ordinates</td>
<td>Important for treating hyperopia and &gt;3D astigmatism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KPD</td>
<td>&lt;+0.75</td>
<td>+0.75 to +1.5</td>
<td>&gt;+1.5</td>
</tr>
<tr>
<td>Anterior curvature map</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal K pattern</td>
<td>Important when treating hyperopia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>refer to topographical patterns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-S Rabinovich ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skewed Steepest Radial Axis Index (SRAX)</td>
<td>&gt;+2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior-inferior difference on the 4mm circle</td>
<td>&gt;1.5D when the inferior is steeper</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;2.5 when the superior is steeper</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Summary

<table>
<thead>
<tr>
<th></th>
<th>Normal value(s)</th>
<th>Suspected value(s)</th>
<th>Abnormal value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior-posterior Difference</td>
<td>$&lt;5\mu$</td>
<td>$&gt;5\mu$</td>
<td></td>
</tr>
<tr>
<td>Isolated island (or tongue like extension)</td>
<td></td>
<td>might be an indicator for FFKC</td>
<td></td>
</tr>
<tr>
<td><strong>Corneal Thickness map</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td>cone like</td>
<td></td>
</tr>
<tr>
<td>Superior-inferior difference</td>
<td>$&lt;30\mu$</td>
<td>$&gt;30\mu$</td>
<td></td>
</tr>
<tr>
<td>Thinnest location difference between both eyes</td>
<td>$&lt;30\mu$</td>
<td>$&gt;30\mu$</td>
<td></td>
</tr>
<tr>
<td><strong>Keratoconus diagram</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape and location of the curve</td>
<td></td>
<td>-out of normative range-deviation before the 6mm circle</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1</td>
<td>$1.1 - 1.2$</td>
<td>$&gt; 1.2$</td>
</tr>
<tr>
<td>Indices of irregularity</td>
<td>white</td>
<td>yellow</td>
<td>red</td>
</tr>
</tbody>
</table>
phakic-IOL fitting simulation software

- its individual fit in the anterior chamber is simulated
- **Critical distances** are calculated in 3D and shown in each single Scheimpflug image
- **PIOL position** years after surgery is simulated
Cataract Surgeon

- Correct corneal power
- Densitometry
Screening for Calculation of postrefractive surgery
IOL power
Corneal Power Maps

A- Sagittal power map (Axial power map)
B- True net power map
C- Equivalent K-Reading map
D- Total corneal power
True Net Power

- $1.376 - 1/R\text{ ant}$
- $+ 1.336 - 1.376/R\text{ post}$
Figure 6  Snell's law of refraction for anterior and posterior corneas as well as consideration of the principle planes.

Figure 7  Total Corneal Refractive Power Map of a sphere, $r_{	ext{Ant}}=6.5\text{mm}$ and $r_{	ext{Post}}=6.58\text{mm}$. 
Holladay Report

- The Holladay Report is a software upgrade which can be easily installed by every Pentacam user.
### OCULUS - PENTACAM

<table>
<thead>
<tr>
<th>Zone Diameter</th>
<th>1.0 mm</th>
<th>2.0 mm</th>
<th>3.0 mm</th>
<th>4.0 mm</th>
<th>5.0 mm</th>
<th>6.0 mm</th>
<th>7.0 mm</th>
<th>8.0 mm</th>
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<td>K2</td>
<td>K1</td>
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<td>Total Refractive Power</td>
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</tbody>
</table>

### Distribution of Sagittal Curvature (Front) in Actual Zone

Power Calculations in Actual Zone

- K1: 38.3 (178°)
- K2: 37.6 (188°)

### Sagittal Curvature (Front)

- Apex
- Zone
- Pupil

- X: 0.00
- Y: 0.00
Quantification of the densitometry

camera-/slit position and image

reflex at the Bowman layer

objective quantification of the Densitometry in the chosen point

basis for quantification is the grey scale of the image, standardize from 0 to 100.
Lens density analysis along a certain line or in a certain area
Glaucoma Surgeon
Anterior Chamber Depth

Application:

- pre. op. planning of phakic lens implantations
- glaucoma precaution
Anterior Chamber Analyzer

Correction of Intraocular Pressure

* IOP measured tonometrically
  15 mmHg

* Pachymetry and keratometry data
  Thickness (apex): 448 μm

ICP Correction

* Corrected by: Ehlers
  Shah
  * (Dresden)
  Dissengor/Pye
  User defined

* POST LASIK, myopic eyes:
  Kohlhees

* ICP change (Sum): +4.1 mmHg
* Corrected IOP: 19.1 mmHg

Pupil Center:
+ 447 μm  +0.20  -0.03

Thinnest Locat.:
O 447 μm  +0.21  -0.29

Chamber Volume:
132 mm³  Angle: 26.6°

A. C. Depth (Int.):
2.49 mm  Pupil Dia: 2.35 mm

Enter IOP IOP(cor):
19.1 mmHg  Lens Th.:
Angle: The average value of anterior chamber angle. An angle less than $25^\circ$ should alert us to check the patient for angle closure glaucoma.

Chamber volume: Volume less than 100 mm$^3$ should alert us to check the patient for angle closure glaucoma.
Screening for LASIK, PRK etc.

We recommend using the following maps and analyzing displays:

- **4 maps refractive**
  To check pachymetry, topography and the elevation maps of both corneal surfaces.

- **Keratoconus detection and quantification**
  To check for keratoconus and if corneal thickness progression is in the normal range, to have information about the corneal stability.

- **Zernike Analysis**
  especially for re-treatments to see whether there are high order aberrations (highlighted in red).

- **Important values**
  Rf and Rs, Asti and Axis, Q-value, QS, pachymetry in the thinnest spot and in the pupil centers, border values in the elevation maps (ant.: < 12μm, post.:< 15μm).
GLAUCOMA SCREENING

- Overview screen
  look at the chamber angle in the Scheimpflug images and to the corneal thickness. Correct the tonometrically measured IOP with the implanted correction tables. The chamber depth and chamber volume is obviously small, usually > 100mm³ in case of angle glaucoma risk patients.

- Important values
  ACD, chamber volume, chamber angle, Q-value, QS, pachymetry, IOP-correction.
Jupiter at 1 pixel at the point of the arrow.
The Earth is not visible at this scale.
Antares is the 15th most brilliant star in the night sky. It is located at more than 1000 light years.
The simple formula
"D=1.3375 – 1/R" is used to calculate corneal power.

Placido based topographers calculate the refractive power of the cornea with the approximation that the ratio between back/front power of the cornea is 82% which leads to an overall corneal refractive index of 1.3375
True Net Power

Goal is to determine the power of the cornea over the area of the pupil projected onto the cornea (Entrance pupil, 4.50 mm center cornea)

General:

Conventional topographer systems use an approximate refractive index of 1.3375 for anterior refractive power calculation, assuming radii ratio back/front is 82%

In virgin corneas, the difference is negligible, but cornea after refractive surgery, usually have a big difference from the center to the periphery, so another significant error is made

Limitations: Post Lasik, high astigmatism and irregularities, keratoplastik etc

Used refractive values:

1 between air to tear film,
1.376
1.336

Keratometric Deviation Map

= Difference between

True Net Power Map and sagittal topo map