Corneal Topography Made Easy !!

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Poll Question 1

What is your position?

1. Ophthalmologist
2. Ophthalmologist-in-training (registrar/resident)
3. Nurse
4. Ophthalmic Technician / Allied Health
5. Medical Student
6. Mixed Group of Different Positions
Introduction

• Corneal tear film air interface provides two third of the vergence of eye.

• Plays important role in the quality of the optics of eye

• Small amount of surface distortion greatly reduces quality of retinal image.

• Direct examination with biomicroscope does not provide enough resolution to detect vision threatening irregular astigmatism.
Evolution

- Pre computerized era

Placido disc
keratometry
keratoscopy

keratometry
keratoscopy
Placido disc/ Reflective technology

Low power
…mires are…
- larger in diameter
- broader in width
- widely separated

Higher power
…mires are…
- smaller in diameter
- narrower in width
- crowded
Limitations of placido based systems

- No Analysis of Posterior Surface
- No Representation of Thinning
- Limited Data in Scarred Corneas
- Coverage Limited to 9.0 mm
- High Incidence of False Positives
The next generation...

ORBSCAN
Slit scanning

PENTACAM
Scheimpflug imaging

VISANTE OMNI
OCT based
The next generation...

TMS 5  
Galilei  
Sirius 3D
ORBSCAN Slit scan vs Reflective

- Data = specular reflected image of a light pattern.
  - Specular reflection is direction dependent.
    - Gives surface slope.
- Data = back-scattered slit-beam image.
  - Back-scatter is omni-directional.
    - Gives surface height.
TOPOGRAPHY

SLOPE/ GRADIENT

ELEVATION/ HEIGHT
Scheimpflug Principle
Scheimpflug Principle

In photography, the Scheimpflug principle is a method for aligning the optical axis of the lens with the plane of the image to achieve a specific effect. If you use a lens that has a hyperfocal distance, the depth of field will be from near to infinity. For example, if your camera has a hyperfocal distance focus at 18 feet, the depth of field will be from near to infinity.
Schiempflug Principle

Scanning slits measure several surfaces

- anterior cornea
- posterior cornea
- anterior lens
- anterior iris
- projector reflex
- fixation reflex
- limbus
Why do we need to look at the scale?
0.5 D steps
Dr PVK
N1 Y1765 M2728
OD - 08/24/2007, 2:46:55 PM

Sim K's: Astigmatism:
Max: 49.8 D @ 100 deg
Min: 47.8 D @ 10 deg

3.0 MM Zone: Irregular ± 0.9 D
Mean Power: 48.3 ± 0.7 D
Astrom Power: 1.6 ± 0.6 D
Steepest Axis: 101 ± 19 deg
Flattest Axis: 11 ± 19 deg

5.0 MM Zone: Irregular ± 2.4 D
Mean Power: 47.2 ± 1.6 D
Astrom Power: 0.7 ± 1.7 D
Steepest Axis: 118 ± 34 deg
Flattest Axis: 22 ± 33 deg

White-to-White [mm]: 11.0
Pupil Diameter [mm]: 3.9
Thinnest: 488 µm (0.252, -0.252)
ACD (Front) 3.30 mm
Kappa: 0.893 @ 203.64°
Kappa Intercept: -0.01, 0.26

2.0 D steps

Keratometric
Axial Power
Thickness
Dr PVK
N1 Y1765 M2900
OD - 09/12/2007, 11:14:53 AM

P. V. K.
L V PRASAD EYE INSTITUTE

Sim K's: Astig. -1.9 D @ 172 deg
Max: 48.0 D @ 82 deg
Min: 44.1 D @ 172 deg

3.0 MM Zone: Irreg ± 1.4 D
Mean Pwr: 45.1 ± 1.1 D
Astrom Pwr: 1.7 ± 0.9 D
Steep Axis: 62 ± 22 deg
Flat Axis: 175 ± 22 deg

5.0 MM Zone: Irreg ± 1.6 D
Mean Pwr: 44.8 ± 1.1 D
Astrom Pwr: 2.0 ± 1.2 D
Steep Axis: 65 ± 26 deg
Flat Axis: 176 ± 25 deg

White-to-White [mm]: 11.9
Pupil Diameter [mm]: 3.8
Thinnest: 493 um @ (0.1, 0.5)
ACD (Eq): 3.71 mm
Kappa = 0.69 @ 170.69
Kappa Intercept: -0.65, 0.65

Keratometric
0.5 D Color Steps
Axial Power

Thickness
0.92 Pachymetry
10 mic Color Steps
Larger steps: More Specific
Smaller steps: More Sensitive
Color coding

Red

reference coloring

Blue

red-shifted coloring

blue-shifted coloring
Elevation can be positive or negative. Red is high and positive (anterior to the reference surface).
Red is thinner and blue is thicker
Poll Question 2

Why are color scales important?

1. Provides a graphic representation of data
2. Important to look at the steps
3. Falsely color coded by internationally accepted criteria
4. All of the above
Elevation Topology: Central Hill

Prolateness of the normal cornea causes it to rise centrally above the reference sphere. The result is a central hill.

Immediately surrounding the central hill is an annular sea where the cornea dips below the reference surface.

In the far periphery, the prolate cornea again rises above the reference surface, producing peripheral highlands.
The regular astigmatic cornea is **toric**, meaning that meridional curvature has maximum and minimum directions, 90 degrees apart.

The **sharp (or steep) profile** falls below the reference surface.

The **flat profile** rises above the reference surface.

The resulting elevation topology is a **central saddle**.
Poll Question 3

What is the management of the above described case

1. Advise for collagen crosslinking
2. Consider the age of the patient, associated ocular co morbidity like allergy
3. Contact lens trial
4. Avoid eye rubbing
5. All of the above
Pseudokeratoconus

Contact lens warpage

Misalignment artifact

Tear meniscus artifact

External pressure on the globe
PMCD

- Classical Butterfly appearance.
- Marked flattening of the cornea along the vertical axis and steepening of the inferior cornea superior to the site of lesion with the steepening extending to the horizontal hemi-meridians.
- ATR > 4D.
Terriens Marginal Degeneration

- Perilimbal corneal thinning.
- High amount ATR astigmatism.

Keratoglobus

- No characteristics topography features.
Choosing a Topographer for your practice
Poll Question 4

Do you use topography in your routine practice?

1. Yes
2. No
Poll Question 5

What topographer do you use?

1. Orbscan
2. Pentacam
3. Sirius
4. Nidek
5. iTrace
6. Cassini
7. Atlas
8. Tomey
9. OCT based
10. Others
Reflection based
• Keratometry
• Photokeratoscopy
• Videokeratoscopy

Projection based
• Rasterstereography
• Laser interferometry

Slit scanning based
• Orbscan

Scheimpflug based
• Pentacam
• Galelei
• Sirius

Spot reflection-based
• Cassini

Basic Principles of topographers

OCT based
• Optovue Rtvue
• Tomey

Hybrid topographers
• iTrace
• Nidek OPD III scan
Choosing a Topographer depends on your practice

1) Pentacam
2) Galilei
3) Placido

Topographer + Abberometer
1) Orbscan
2) OPD III
3) i trace
Keratoscope/Placido

Time tested
Standard of care

Reflection based topography
Picks up minute corneal irregularities
1) Decision for premium IOL
2) Cataract pre operative Scan
3) Densitometry map
5) Cataract grading
4) Holladay EKR report
6) Belin-Ambrosio Enhanced ectasia display
Normal quad map
Deviation from normal parameters
IOL Calculation for patients post refractive surgery

Keratometry - Total corneal refractive power

Optical Biometer

Axial length

IOL power
1) Lens densitometry analysis
2) Glaucoma analysis
3) Dry eye evaluation
4) Keratoconus screening indices
5) Contact lens fitting
Advantage: Sirius System

- Combines the images from Scheimpflug with the Placido system
- **Scheimpflug data** – Anterior and posterior elevation, thickness
- **Placido system** – Corneal Curvature, power
- **Keratoconus Summary** - Focuses on risk of ectasia
- **Aberrometry analysis** - explains visual discomfort
- **Autofit module** – Decisions in contact lens fitting
Summary Maps

Corneal Thickness (30μm Steps)

Tangential curvature (0.3mm/1.5D Steps)

Anterior Elevation (10μm steps)

Posterior Elevation (10μm steps)
Dry eye evaluation

Tear film irregularities

Placido image to identify tear film quality

Area of gland drop outs
1) G6 software for IOL power calculation

2) Corneal Wavefront analysis

3) Keratoconus predictor indices

4) Best Fit Toric Asphere
G6 software calculates IOL power

IOL power with various formulae

Anterior chamber depth
Anterior BFTA

Posterior BFTA

Keratoconus Probability & Indices

- KPI: 6.7%
- CLMiae: 1.950
- IS: 2.080
- SAI: 0.890
- Kprob: 5.6%
- PPK: 9.2%
- OSI: 2.51D
- OSI: 1.67D
- OSI: 0.10D
1) Keratoconous diagnostic criteria

2) WTW for ICL Calculation.
Keratoconus (Anterior & posterior) Red flags

ORBSCAN

1. The ratio between radius of Anterior BFS and radius of posterior BFS:
   - 1.22 to 1.27 suspect
   - Above 1.27 No Go

2. Power of posterior BFS:
   - Above 55D Suspect

3. On the posterior Flat:
   - Above 50 microns Suspect
   - Difference between highest & closest lowest Points: Above 100 microns Suspect

4. Corneal thickness index (CTI):
   - Above 1.16 Suspect

5. Irregularity
   - 3 mm zone above 1.5 D Suspect
   - 5 mm zone above 2.5 D Suspect

6. On the Axial keratometric map if you see butterfly or broken bowtie pattern Suspect

7. Look at normal band scale maps in case of suspicion

8. Quad map - 3 Step Rule:
   - 1 Abnormal Map Caution
   - 2 Abnormal Maps Concern
   - 3 Abnormal Maps Contraindication
PRINCIPLE

TOTAL CORNEAL ASTIGMATISM

Uses patented multi-coloured LED point-to-point ray tracing technology, which identifies every three points and defines ‘local elevation’.

This process is theoretically unbiased by media opacity and differs from the center to periphery dependence of data processing that occurs with Placido-disk topographers.
Integrated system along with devices from I-Optics and TrueVision 3D which allows information to be transferred seamlessly between the Cassini Corneal Topographer, LensAR laser system, and TrueGuide system.
1) Evaluating aberrations
2) Premium IOL Planning
3) Post IOL implantation analysis
4) Quality of vision parameters
Evaluating aberrations

- Increased internal HOA’s
- Slit lamp showing no cataract
- Dysfunctional lens syndrome
Pupillometry & Autorefractometer

Autokeratometer

Topographer & Corneal Indices

Toric Planning, Holladay Report

Meibography

Keratograph

OPD III
# Cataract pre-op summary

## Refraction: VD = 12.00mm

<table>
<thead>
<tr>
<th>Sph</th>
<th>Cyl</th>
<th>Axis</th>
<th>RMS</th>
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<tbody>
<tr>
<td>+0.00</td>
<td>-0.25</td>
<td>106</td>
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</table>

### Center (3.68mm)

<table>
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<th>Sph</th>
<th>Cyl</th>
<th>Axis</th>
<th>RMS</th>
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<tbody>
<tr>
<td>+0.50</td>
<td>-1.00</td>
<td>109</td>
<td>0.51D</td>
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</tbody>
</table>

### Diff

<table>
<thead>
<tr>
<th>Sph</th>
<th>Cyl</th>
<th>Axis</th>
<th>RMS</th>
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<td>+0.50</td>
<td>-0.75</td>
<td>3</td>
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### Irregularity @3.68mm (HO RMS)

- **Total**: 0.204μm
- **Cornea**: 0.134μm
- **Internal**: 0.226μm

## Cornea

<table>
<thead>
<tr>
<th>Classification/Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (97.2%)</td>
</tr>
<tr>
<td>Other (2.8%)</td>
</tr>
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</table>

### Photopic

- **SDP / SRI / SAI**: 1.25 / 0.14 / 0.47

### Classification/Indices

- **Corneal asphericity**: Q: -0.03  e: 0.18
- **Cornea SA**: 0.277μm @6.0mm

## Cyl: VD = 0.0mm

<table>
<thead>
<tr>
<th>Total</th>
<th>Cornea</th>
<th>Internal</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.25@106°</td>
<td>+0.30@36°</td>
<td>-0.18@86°</td>
</tr>
</tbody>
</table>

## Pupil Information

### Photopic

- **Dist to P/M**: 0.08@104°

### Mesopic

- **Dist to P/M**: 3.68mm / dist 0.28@15°
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Refractive Surgery</th>
<th>Cataract Surgery</th>
<th>Highlights</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| Pentacam   | • Elevation Topography  
             • Bad display | • Premium IOL  
             • ERK map | Widely used and accepted | Expensive  |
| Orbscan    | • Basis of Keratoconus scoring  
             • WTW measurement | - | Time tested | Repeatability issues  |
| Galilei    | • Keratoconus indices  
             • BFTA/ CLMI | G6- IOL Calculations | Emerging role | Not widely used  |
| Sirius     | • Keratoconus indices  
             • Dry eye test | - | Contact lens fitting, Meibography | Not widely used  |
| OPD III    | • Autorefractometer | - | Abberometer | Repeatability issues  |
| Casini     | - | Gives posterior astigmatism | Posterior astigmatism | Repeatability issues  |
Need of a good Topographer for a cataract and a refractive surgeon

- Refractive indices
  - Keratoconus Screening
  - Refractive Sx
    - Pentacam placido
- Q value
  - Optimising IOL
  - Topoguided Rx
    - Pentacam placido
- WTW value
  - ICL Calculation
    - Orbscan
- Meibography
  - Dry eye Workup
    - Sirius
- Biometry
  - IOL Calculation
    - Galilei
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L V Prasad Eye Institute

Excellence ● Equity ● Efficiency