WHAT IS CORNEAL TOPOGRAPHY?

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WHAT IS TOPOGRAPHY?
• 3-D REPRESENTATION OF SHAPE ON A 2-D (FLAT) PAPER

CORNEAL TOPOGRAPHY
• GEOGRAPHIC MAP OF THE CORNEA
• MEASURES CORNEAL CHARACTERISTICS
  – shape
  – power
• REPRESENTED BY COLORS
WHY USE TOPOGRAPHY?

- ANTERIOR SEGMENT DISEASE
  - diagnosis of corneal disorders
  - management of corneal disorders (change)

- CONTACT LENS
  - initial fitting and/or follow-up

- SURGERY
  - pre-op cataract surgery
  - pre/post-op refractive surgery (LASIK, PRK, etc)

HISTORY OF TOPOGRAPHY

- gross observation
- molding of cadaver eyes
- molding of live eyes
- Placido disc images
- keratometry

- Placido disc photos
- computerized color mapping
- slit-scanning technology
- Scheimpflug imaging
- ??
**COMPARISON**

<table>
<thead>
<tr>
<th>Keratometry</th>
<th>Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures central 3mm of cornea</td>
<td>Measures limbus-limbus and beyond</td>
</tr>
<tr>
<td>Analyses two meridians at a time</td>
<td>Measures all meridians at once</td>
</tr>
<tr>
<td>Regular astigmatism only</td>
<td>Regular and irregular astigmatism</td>
</tr>
<tr>
<td>No data analysis</td>
<td>Extensive data analysis</td>
</tr>
<tr>
<td>Accuracy to ±0.12D</td>
<td>Accuracy to ±0.01D</td>
</tr>
<tr>
<td>Tear film stability critical</td>
<td>Tear film stability critical</td>
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</tbody>
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**CORNEAL ASTIGMATISM**

- **Kcyl (keratometry, topography)**
- **amount on the cornea**
- **47.50/44.50@090**
- To correct steeper meridian (180)
  - -3.00 in 180
  - -3.00 x 090
  - -3.00 x 090

**REFRACTIVE ASTIGMATISM**

- **Rx cyl**
- **amount in the refraction/spectacles**
- **Spec Rx: -1.00 -3.00 x 090**
- **Spec cyl: -3.00 x 090**
AUTOREFRACTOR PRINTOUTS

TOPOGRAPHY PRINTOUTS

MERIDIAN VS. AXIS
• THE “AT” VS. “AXIS” PROBLEM....
  • meridian = location
  • "at"
  • "in"
  • axis = 90 degrees away
  • "axis"
  • "a"
**ASTIGMATISM CLASSIFICATION**

- **WTR (WITH THE RULE):** 30 degrees on either side of 180, inclusive
  - 180 to 030
  - 150 to 180
- **ATR (AGAINST THE RULE):** 30 degrees on either side of 90, inclusive
  - 060 to 120
- **OBLIQUE:** Degrees between WTR and ATR
  - 031 to 059
  - 121 to 149

The cut-offs go with the primary meridians:
- e.g. 030 and 150 are considered WTR – not oblique
- e.g. 060 and 120 are considered ATR – not oblique

**CLASSIFY THE ASTIGMATISM:**

- -1.00 X 180?
- -5.00 X 090?
- -3.75 X 062?
- -3.00 X 060?
- +2.00 X 101?
- -0.00 X 030?
- -1.00 X 000?
CORNEAL ASTIGMATISM

- WTR: STEEPER IN THE VERTICAL MERIDIAN
- ATR: STEEPER IN THE HORIZONTAL MERIDIAN

HAND-HELD PLACIDO DISC

- 20 CM DIAMETER DISC W/ HANDLE
- CONCENTRIC BLACK AND WHITE RINGS
- CENTRAL LENS
- LOOK THROUGH CENTER LENS
- SEE PLACIDO’S DISC IMAGE REFLECTED ON CORNEA

PLACIDO DISC IMAGE
PLACIDO DISC IMAGE
- Assess ring separation
- Close = steeper
- Easier with high astigmas

TOPOGRAPHY METHODS
- Placido Disc [Front surface only]
- Horizontal slit-scan
- Rotating Scheimpflug
- Rotating optical coherence tomography (OCT)

POPULAR TOPOGRAPHER/TOMOGRAPHER MODELS
- Humphrey Atlas (Zeiss)
- Medmont E300 (Medmont Intl PTY)
- Reessvit (Veatch)
- OrbScan (Bausch + Lomb)
- Keratron Scout (Optikon/Eyequip)
- Pentacam (Oculus)
- Cirrus As-OCT Module (Zeiss)
- And many more...
SCLERAL IMAGING DEVICES

• SMAP 3D (PRECISION OCULAR METROLOGY)
• MEDMONT E300 ESH SOFTWARE (MEDMONT INTL PTY)
• PENTACAM CSP MODULE (OCULUS)
• EYE SURFACE PROFILER/ESP (EAGLET EYE)

TOPOGRAPHIC MAPS

• SAME CORNEA; DIFFERENT DATA!
• POWER VS. CURVATURE (MM AND D OPTIONS)
• TYPES
  - axial
  - tangential
  - refractive power
  - elevation
  - difference
  - photokeratoscopic
  - numerical
  - irregularity
  - keratometric
  - profile
TOPOGRAPHER DIFFERENCES

- Method of obtaining image
- Amount of the eye imaged
- Output (front/back/both surfaces imaged)
- Design (printouts and maps)
- Cone type (small or large/open)

PLACIDO DISC IMAGE / VIDEKERATOSCOPY

MAPS
SCHEIMPFLUG IMAGING

CONTACT LENS FITTING SOFTWARE

IN GENERAL FOR TOPOGRAPHY...

- REFRACTIVE PROPERTIES OF THE CORNEA
  - power maps
    - in dipters (D)
- SHAPE PROPERTIES OF THE CORNEA
  - curvature maps
    - in millimeters (mm)
IN GENERAL FOR TOPOGRAPHY...

- Hot colors are steeper
- Cool colors are flatter
- WTR is vertical bow-tie in red
- ATR is horizontal bow-tie in red
- Keratoconus is an inferior "hot spot"

ASTIGMATISM ANALYSIS

- Questions to ask with an axial map:
  - What is the direction of the astigmatism? (WTR, ATR, oblique, or is there none present)
  - What is the amount of the astigmatism? (in diopters, recorded like a spec Rx, e.g. -2.00 x 180)
  - What is the location of the astigmatism? (central, limbus-limbus, inferior, asymmetric)
  - What is the type of the astigmatism? (regular, irregular)
Given simulated keratometry readings of:

- 45.50/41.50@090
- 43.75/44.75@090

AMOUNT?
LOCATION?

CENTRAL
OR
LIMBUS-TO-LIMBUS

TYPE?

REGULAR
OR
IRREGULAR
IRREGULAR ASTIGMATISM

You can tell it’s irregular because there’s no neat “bow-tie” appearance to the difference in K readings. This means the cornea isn’t steeper in one meridian and flatter in another. In fact, this cornea shows steepness in one half of the cornea (inferior) and flatter topography centrally with a sort of mid-range dioptric value superiorly.

TYPE?

REGULAR ASTIGMATISM

There is a clear bow-tie appearance to the difference in K readings. This means the astigmatism is regular in nature.
TOPOGRAPHY MAPS

- AXIAL: NORMAL
- TANGENTIAL: INSTANTANEOUS; SENSITIVE TO CHANGE
- REFRACTIVE POWER: ORTHOKERATOLOGY; SURGERY
- ELEVATION: SURGERY
- DIFFERENCE: ORTHOKERATOLOGY; SURGERY

AXIAL

- AVERAGE POWER OF CORNEA MEASURED FROM CENTER
- "KERATOMETRIC VIEW"
- SIMPLE TO VIEW
- REPRODUCIBLE
- "SMOOTHING" EFFECT MAY GIVE FALSE IMPRESSIONS
- A.K.A. SAGITTAL = COLOR = DEFAULT MAPS

TANGENTIAL

- INSTANTANEOUS RATE OF CURVATURE
- MEASURED "TANGENT" TO THE NORMAL
- MORE SENSITIVE TO CHANGES
- MORE DETAILED THAN AXIAL
- USEFUL FOR IRREGULAR CORNEA PATIENTS
REFRACTIVE

- GIVES POWER IN DIOPTERS
- DESCRIBES REFRACTIVE CONTRIBUTION OF THE CORNEA
- USEFUL IN REFRACTIVE & CATARACT SURGERY

DIFFERENCE

- CAN SHOW CHANGE OVER TIME
- USEFUL IN ORTHO-KERATOLOGY
- USEFUL IN MONITORING CORNEAL DISEASE PROGRESSION

WAVEFRONT TOPOGRAPHERS: HOAS

- LOWER-ORDER ABERRATIONS (LOAS)
  - hyperopia, myopia, astigmatism (85%)
- HIGHER-ORDER ABERRATIONS (HOAS)
  - coma, trefoil and spherical aberration (15%)
  - a.k.a. Zernicke polynomials (mathematics)
CORNEAL SHAPE

ECCENTRICITY

- POSITIVE = PROLATE
- SPHERICAL = ZERO
- NEGATIVE = OBLATE

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Most are positive and fairly low between 0 and 1

- Negative e-values and high positive values (>0.7) almost always have a cause
  - ortho-k (negative)
  - refractive surgery (negative)
  - keratoconus (highly positive)

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PROLATE

OBLATE

I CAN SEE CLEARLY NOW... (GETTING THE BEST MAPS)
**OBTAINING THE BEST IMAGES**

- Take multiple scans
- Look for artifacts
- Instill lubricating drops (artificial tears) if needed
- Instruct patient appropriately
  - Blinking
  - Head position

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**REIMBURSEMENT**

- Most third parties will not reimburse for 367.21
  - Regular astigmatism
- Medical diagnosis needed
  - Keratoconus
  - Irregular astigmatism
  - Corneal opacity
  - Acquired corneal deformity

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**REIMBURSEMENT**

- Physician’s order for the test
  - Medical rationale must be in the chart
- Separate interpretation and report
  - Testing date
  - Comment on testing reliability
  - Printout of the test
  - Diagnosis
  - Impact on treatment and prognosis
  - Physician’s signature