Assessment & management of irregular astigmatism

Athens, March 2018
No financial interest
What is an irregular astigmatism?

- A question that starts at the wrong end...
- How about defining regular astigmatism?
What is a regular astigmatism?

- The meridians of the maximum and minimum curvature of the cornea are at right angles.
What is an irregular astigmatism?

- When the two principal meridians of the cornea are not at right angle to each other
Two types of irregular astigmatism

- Regularly irregular
  Identifiable pattern (e.g. asymmetric bowtie)

- Irregularly irregular
  No recognizable pattern on corneal topography
Iatrogenic ectasia
Preop

3 months

7 months
### WF and CT Summary Display

#### INTERNAL - RMS Total, no Defocus 3.00 mm

<table>
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<tr>
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<th>Value</th>
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#### TOTAL EYE - RMS Total, no Defocus 3.00 mm

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#### OD

- Limbus: 10.45 mm, Pupil: 4.12 mm, Scan: 3.00 mm
- Tracey Refraction: -3.75 D - 1.75 D x 151°
  - 2.00 mm: -4.55 D - 1.67 D x 147°
  - 3.00 mm: -3.76 D - 1.77 D x 151°
  - 5.00 mm: -3.76 D - 1.77 D x 151°
- HC Total @ D <= 3.00 mm: 0.282 μ
  - Coma: 0.036 μ x 127°
  - Spherical Aberration: -0.100 μ
  - Trefoil: 0.153 μ x 6°
- Angle Alpha D = 0.196 mm @ 157°

#### CORNEA - RMS Total, no Defocus 3.00 mm

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#### OD

- Axial Map
  - 39.00 µm
  - 40.00 µm
  - 41.00 µm
  - 42.00 µm
  - 43.00 µm
  - 44.00 µm
  - 45.00 µm
  - 46.00 µm
  - 47.00 µm
  - 48.00 µm
  - 49.00 µm
  - 50.00 µm
  - 51.00 µm
  - 52.00 µm
  - 53.00 µm
  - 54.00 µm
- Refractive Power @ D <= 3.00 mm
  - Steep: 45.44 D
  - Flat: 45.44 D
  - Astigmatism: 0.150 µ
- Effective RP: 7.43 mm / 45.44 D
- Central Radius / Power: 45.44 D
- Corneal SphAb @ D = 6.00 mm: +0.150 µ
Irregular astigmatism

- Cannot be corrected with spherocyl lenses
- Correction: RGP CLs, sclerals or surgery
Irregular astigmatism is all around us

- Post corneal/refractive surgery, keratoconus, other corneal pathology, post trauma, post RGP
- Even regular can have an irregular component
- May be missed before toric lens implantation
Identifying irregular astigmatism

- Topography, tomography, wavefront
- But it is still permitted to use common sense:
  To get a general sense of the magnitude of any irregular astigmatism, test the difference between spectacle and RGP visual acuity
Therapy options

- RGP CLs and scleral lenses
- Topography-guided ablations (± CXL)
- Toric IOLs (makes no sense?)
- Intacs, DALK/PK, pinhole sulcus implant
Contact/scleral lenses

- RGP corneal CLs
- Hybrid (RGP center, soft skirt)
- Scleral/mini scleral lenses
Contact/scleral lenses

- Mask irregularities
- Regular refractive surface
- RGP: fitting approaches/peripheral curves
- Scleral: excellent in advanced ectasia, when intolerance to CL
  - No corneal touch, good centration and VA
Irregular astigmatism and CLs

- RGP s remain the first choice for correcting irregular astigmatism
- For the majority of such patients, it is the optimal solution for their visual problems
Topography-guided ablations

- For irregular astigmatism after refractive surgery (excentric ablations, small optical zones)
- Also for post-PK, scars, trauma, KC
- Not for thin corneas (<400μ), unstable ectasia, deep scars (DALK, PK)
- BUT topo-guided PRK with CXL for ectasia
Topography-guided ablation

Power Difference Map

Cylinder change: 0.34 D (Induced: 0.49 D @ 152)
Mean power difference: 3.75 +/- 1.41 D (N = 2776)

Courtesy G Kymionis
Post-penetrating keratoplasty irregular astigmatism
Topo-guided PRK+MMC
Simultaneous Topography-Guided Photorefractive Keratectomy followed by Corneal Collagen Cross-linking for Keratoconus

GEORGE D. KYMIONIS, DIMITRA M. PORTALIOU, GEORGE A. KOUNIS, ALIKA N. LIMNOPOULOU, GEORGIOSS KOUNIS, AND MIKHAEL G. GRETZIELOS
There are still irregular corneas in which topo-guided ablation is not applicable:

- Very thin corneas – less than 400 μm
- Deep corneal scar

- INTACS implantation / DALK or PK
- DALK or PK
How in the world can an IOL correct an irregular cornea?

Since the cornea is the cause of the irregular astigmatism, what’s the point of an IOL?
Toric IOLs in irregular astigmatism

- The toric IOL corrects the regular component of the astigmatism (most patients have some of both)
- If the irregular component is minor, a satisfactory visual result can still be obtained
- Pseudophakic, phakic and piggy-back variants
Toric IOLs in irregular astigmatism

- Young KC patient, still with low degree of irregular astigmatism
  Can be stabilized with CXL
- Then a RGP lens can be worn
- If CL intolerance develops ➔ phakic toric IOL
  (the CXL may prevent further irregularity)
A new and promising approach

- Customized CXL for KC
- Only the relevant tissue is treated
Customized Corneal Cross-linking

- Strengthens only weak parts of the KC cornea (more energy needed where weak)
- Customized CXL as safe as standard CXL
- More flattening of Kmax, faster epi healing
Kmax decreased by 3.6D
Standard Corneal Cross-linking: One-Year Results

Kmax decreased by 0.8D