Topography-Guided Custom Ablation in Irregular Astigmatism - Alternatives in fitting of the Targeted Surface and Dealing with the Remodeled Epithelium

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Disclaimer

- No financial or proprietary interests in any of the products mentioned in the presentation
1. How to optimally fit the targeted surface and design an ablation that consumes the least amount of tissue and smoothly translates to the untreated cornea?
Virgin cornea

I.A. - decentered corneal optics

"View" through the original axis = visual distortion

Neurovisual Adaptation occurs

Eye rotates and "finds" an "adapted" axis in order to lessen the distortion
What are our alternatives in treatment of IA?

- **A:** Correct the original mistake by re-identifying the original visual axis—and then treat?

- **B:** Treat on top of “the mistake” and use the information referenced to a new “adapted” visual axis?
  - Topo (placido) or aberrometry information acquired by monocular exam is bound to the “secondary tilted” fixation axis.
How does the treatment of IA, based on Fixation Axis, affect the cornea (if the tilt is kept unchanged)?

Targeted surface perpendicular to the visual (fixation) axis results in:

1. **Large tissue consumption**
2. Most of the ablation gets placed on the already treated area
3. Causes an **abrupt transition**
How to find the **Restored Morphological Axis** (iVIS)

- The topography information from the entire corneal surface (both the decentered and unaffected) is analyzed by software, along with the axial length of the eye.

- **Restored morphological axis** is generated.
How does the treatment of IA, based on Restored Morphological Axis, affect the cornea?

Targeted surface perpendicular to the morphological axis results in:

1. **Low tissue consumption**
2. Most of the ablation gets placed on the previously untreated area
3. Results in a smoother transition
Visual Axis TGA (in decentered LASIK)

Preop. AstraMax axial keratometric map

Preop. Orbscan floating elevation map

The deepest ablation area

Max ablation depth 53µ

Simulated postop. floating elevation map (Transition zone Δ elevation 96µ)
Restored morphological Axis TGA (the same case)

Preop. AstraMax axial keratometric map

Preop. Orbscan floating elevation map

The deepest ablation area

Max ablation depth 23µ

Simulated postop. floating elevation map (Transition zone Δ elevation 14µ)
Conclusion

• For CA of decentered optics - **Always compare the ablation map with the topography**
  Make sure that the deepest point is not placed on the already treated area

• Use "restored morphological axis" if available
  • Currently featured only by iVIS-Suite

• For other systems use the "tilt off" option
2. How to deal with epithelium that has remodeled the corneal surface in IA?
Variability of epithelial thickness - Due to remodeling in irregular astigmatism

- Epithelium covering an irregular stroma has a smoothing / filling characteristic
  - Grows thicker over depressions and thinner over elevations

- Morphology of the stromal surface under the epithelium may be very different from the morphology of the epithelial surface

- But the optics and topography of the epithelial surface is the basis of our custom ablation planning

85 µm

 localized epithelial hyperplasia infilling a stromal defect

25 µm
Variability of epithelial thickness - a problem in custom surface ablation

- Custom surface ablation (PRK, LASEK, EpiLASIK...) that involves epithelial removal

- **Must assume** the stromal surface mirrors the epithelial surface, i.e. that the epithelium is of uniform thickness
  - If we expect to achieve the desired corneal shape-change on the basis of custom data acquired with the epithelium still covering the cornea
Variability of epithelial thickness - a problem in custom surface ablation

- In reality, epithelial removal in an irregular cornea will uncover an unmeasured irregular stromal surface.
- Furthermore, the custom ablation applied to this surface will induce new major irregularities.
- Resulting in an outcome quite different from the desired.
Solution A: epithelium may be removed mechanically, alcochol... if:

- The epithelium thickness can be mapped (Artemis, hi-res OCT?) and the custom ablation plan may be modified accordingly, taking into account the uneven epithelial thickness.
- This requires not only the accurate measurements but also registration w.r.t. the ablation plan.
- No commercially available interface between the measuring devices and the custom ablation systems.
Solution B (cTEN by iVIS):

• Epithelium is removed with laser, together with stroma
  • Epithelial removal being an integral part of a single ablation, circumventing the whole problem of the “unknown” stromal surface

• The desired postoperative surface is simply moved below the epithelium into the stroma, by means of a lamellar ablation, which is seamlessly added to the custom ablation plan
Clinical study

- Ongoing prospective study
- Treatment of 100 eyes of 100 patients with visual disturbances due to secondary irregular astigmatism (after previous refractive and other eye surgery, injuries or keratitis)
- The first treatments done in March 2002
- **80 eyes** reached minimum 24 months after surgery
Clinical outcomes
Irregular astigmatism after decentered LASIK

Preoperative

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<tr>
<th>UCVA</th>
<th>SPH</th>
<th>CYL</th>
<th>AXES</th>
<th>BSCVA</th>
<th>ASPH</th>
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Multiplopia, glare, haloes

Postoperative 12 M.

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Irregular astigmatism and very oblate asphericity after RK

Preoperative

Postoperative 12 M.

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Glare, haloes,
Night vision disturbances

Ablation plan

Simulated outcome
Irregular astigmatism after PK

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Simulated outcome

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Multiplopia, Glare, haloes, Night vision disturbances

Thank you!