Q Value or Spherical Aberration: Which is More Important to Correct?

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Prolate & Oblate Corneal Shapes

Prolate corneas have a Q value < 0.0 based on corneal topography.

Oblate corneas have a Q value > 0.0 based on corneal topography.
“Prolate” Ablation Shape

- Attempts to obtain prolate geometry of the cornea based on topography “in order to preserve spherical aberration” by
  - Optimum Q value (population based)
  - Constant Q value (preserve pre-op Q value)
- Ignores wavefront information about entire optical system

Prolate Cornea

Spherical Cornea

Oblate Cornea

Prolate

Prolate

Prolate

Prolate

Pre-operative shape

“Prolate” treatment
Corneal Asphericity = Spherical Aberration?

Q value:
Best fit ellipsoid (conic constant) to describe apical ratio of change

Spherical Aberration:
Depends on the curvature of the surface

• All LVC changes corneal curvature
• Same Q value, with different curvature will result in different amount of spherical aberration
Wavefront-Driven Treatment

- Goal is to correct all optical aberrations in the eye

Pre-operative shape

Wavefront treatment
Objectives

Pre-operative shape

Wavefront treatment

“Prolate” treatment
Objectives

● To evaluate the impact of corneal asphericity on visual performance following wavefront-guided LASIK procedures

  ● Optimum Q value? (1 Q value?)
  ● Constant Q value? (dQ = 0)
Data

FDA Clinical Trial

- CustomVue
- Myopic-astigmatic LASIK
- Six clinical sites
Clinical Sites

- Bascom Palmer Eye Institute
- Baylor Vision, Baylor College of Medicine
- Coleman Vision
- Kraff Eye Institute
- Maloney Vision Institute
- Wilmer Eye Institute
Subjects

- 255 myopic eyes
- Age: 35.00 ± 7.90
- Pre-op Rx: -3.21DS ± 1.31
- Pupil: 6.85mm ± 0.82
- Wavefront-guided treatment with 6 months of follow up
Methods

Visual acuity

- Vector Vision
- LogMAR chart (ETDRS)
- 85 cd/m²
Methods

Contrast sensitivity

- Vector Vision
- 3, 6, 12, & 18 cpd
- ~ 0.15 log CS step
- Day: 85 cd/m²
- Night: 3 cd/m²
- Glare: >100x chart
Methods

Corneal Topography
Pre-op Corneal Shape

- Best corrected visual acuity and corneal shape

No relationship between pre-op BCVA and corneal shape
Wavefront-Guided Ablation

- Uncorrected visual acuity and corneal shape
- 6 months post-op

No relationship between post-op UCVA and corneal shape

No optimum Q value
Wavefront-Guided Ablation Shape

- Will the direction and the amount of change in Q value affect post-op UCVA?

No relationship between post-op UCVA and the direction of corneal shape change.

Constant Q value wouldn’t work.
Wavefront-Guided Ablation Shape

- Best corrected visual acuity and corneal shape 6 months post-op

No relationship between post-op BCVA and corneal shape

No optimum Q value
Best corrected visual acuity and corneal shape 6 m post-op

No relationship between the change of post-op BCVA and the direction of corneal shape change

Constant Q value wouldn’t work
Photopic contrast sensitivity (18c/d) and corneal shape 6m post-op

No relationship between contrast sensitivity and corneal shape

No optimum Q value
Photopic contrast sensitivity (18c/d) & change of corneal shape 6m post-op

No relationship between contrast sensitivity and corneal shape

- Constant Q value wouldn’t work
## Correlation Between Contrast Sensitivity & Corneal Shape

6 months post-op

<table>
<thead>
<tr>
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<th>Photopic</th>
<th>Mesopic</th>
<th>Mesopic-glare</th>
<th>Disability glare</th>
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No optimum Q value
Correlation Between Contrast Sensitivity & Change in Corneal Shape
6 months post-op

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The direction and amount of change in Q value does not affect contrast sensitivity.

Constant Q value wouldn’t work.
Correlation Between Change in Contrast Sensitivity & Change in Corneal Shape
6 months post-op

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The direction and amount of change in Q value does not affect change in CS

Constant Q value wouldn’t work
Multivariate Analysis

- Controlled for pupil size, corneal curvature, age and HOAs
  - Age predicts CS
    - Inversely correlated
  - Spherical aberrations predicts CS
    - Inversely correlated
  - Q value and the change of Q value have no relationship with VA and CS

Does Wavefront-Guided treatment improve visual function?
# Wavefront Guided Ablation

<table>
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<tr>
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<th>Worse</th>
<th>Same</th>
<th>Better</th>
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<tr>
<td>dBCVA</td>
<td>0%</td>
<td>93%</td>
<td>7%</td>
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\[ d \text{ BCVA} = 6M \text{ BCVA} - \text{Pre-op BCVA} \]

*pre-op VA adjusted for trial lens minifying effect
Wavefront Guided Ablation

Contrast Sensitivity Function

Prolate and oblate corneas have equal chance to have improved performance in contrast sensitivity

Tuan K. JCRS 2006, Vol.32, No.2
Wavefront-Guided Ablation Shape

Case Example 1

Clinic: Bascom-Palmer

6-month UCVA: 20/12.5

6-month BCVA: 20/12.5

Q value: +0.38 OBLATE

Spherical Ab: 0.12 µm

Results: Excellent acuity (note the PSF) and contrast sensitivity
Case Example 2

Clinic: Bascom Palmer

6-month UCVA: 20/12.5

6-month BCVA: 20/12.5

Q value: -0.38 PROLATE

Spherical Ab: -0.03 μm

Results: Excellent acuity (note the PSF) and contrast sensitivity
Wavefront-Guided Ablation Shape

Case Example 3

Clinic: Wilmer

6-month UCVA: 20/20

6-month BCVA: 20/12.5

Q value: -0.43 PROLATE

Spherical Ab: -0.03 µm

Results: Excellent acuity (note the PSF) and contrast sensitivity
Wavefront-Guided Ablation Shape

Case Example 4

Clinic: Coleman Vision

6-month UCVA: 20/15

6-month BCVA: 20/12.5

Q value: 0.33 OBLATE

Spherical Ab: 0.03 μm

Results: Excellent acuity (note the PSF) and contrast sensitivity
Conclusions

- US FDA clinical trial data show no correlation between corneal shape and visual acuity or contrast sensitivity outcomes.

- Corneal asphericity does not appear to be a determining factor in post-op quality of vision.

- Better visual outcomes are more likely with a customized shape than a standard aspheric shape.

Corneal Asphericity and Visual Function After Wavefront-Guided LASIK

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ABSTRACT

Purpose. In recent years, a theory has been advanced that corneal asphericity in and of itself determines visual function; that the natural, optimal shape of the cornea is prolate; and that changing the cornea from prolate to oblate negatively impacts visual results. This article presents an analysis of the impact of corneal asphericity on wavefront-guided LASIK.

Method. A retrospective analysis was conducted of 160 myopic eyes that had undergone wavefront-guided LASIK. Surgical procedures and data collection were conducted at six clinical sites. Corneal topography, visual acuity, and contrast sensitivity data were collected before and 6 months after surgery. The topographically measured corneal surface of each eye was fitted to a conic, and a Q-value was computed for a 5.5-mm pupil. Multivariate regression analysis was performed to evaluate the correlation between Q-value and visual function. The relationship of changes in the corneal surfaces to visual performance was also investigated.

Results. Preoperative corneas exhibited negative (prolate) conic shape constants. Postoperative corneas were about equally divided between positive (oblate) and negative conics. There was no statistically significant correlation between corneal shape and visual acuity or contrast sensitivity function. Changes in corneal asphericity after surgery had no significant correlation with changes in visual acuity or contrast sensitivity.

Conclusion. Visual acuity and contrast sensitivity after wavefront-guided LASIK are not dependent on corneal asphericity. Neither preserving nor inducing asphericity ensures better visual outcome. Better visual outcomes are more likely to result from the application of a customized shape than a standard conic shape.

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Thank you for your attention!
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