Biomechanically induced aberrations from vertical corneal incisions

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The brief

- Share your clinical experience with astigmatic relaxing incisions and even radial keratotomy incision (vertical) in terms of the aberrations produced and their biomechanical origin.
- What is the effect on corneal optics of incisions cut vertically (anterior-posterior)
My experience

Graft refractive surgery
- Relaxing incisions
- ±Compression sutures
- Incise and suture

Other
- Radial keratometry
- Astigmatic keratotomy
- Cataract surgery
- Trauma, disease etc
But first - principles

- **Incisions cause flattening**
  - At the wound
  - Perpendicular to the wound

- **Sutures cause steepening**
  - At the wound
  - Perpendicular to the wound

- **Coupling**
Simplest case – single incision
Small incision cataract surgery

- Corneal incision induce small, but statistically significant amounts of tetrafoil
- Scleral incisions do not
- Not visually significant

Single incision
Single incision

- Spherical 0.36
- Tetrafoil -0.29, -0.12
- Secondary astigmatism -0.29
- Secondary coma -0.22
- Coma 0.26
Single incision with sutures
Sutures removed
Change with suture removal

Higher-order aberrations

Whole eye wavefront

- Sph: 0.87 D
- Cyl: -2.29 D
- Axis: 5°
- LO RMS: 2.13 μm
- HO RMS: 0.78 μm
- TOT RMS: 2.27 μm
- Pupil: 6.00 mm

Coma

ANSI Z80.28
High hyperopic LASIK

- Extensive thinning of the (mid) peripheral cornea is analogous to (mid) peripheral incision
- Corneal is not uniformly thick
- Thinnest part will cause same biomechanical effect as a single incision
- Flattening perpendicular to the incision
Very high hyperopic LASIK
Summary of single incision

- Flattening over incision
- Flattening in meridian perpendicular to incision
- Astigmatism
- Coma, Trefoil, tetrafoil
- Position and length
- Secondary astigmatism, secondary coma
Multiple incisions
Radial keratometry
Retro-illumination

RE

LE
Corneal Topography

[Image showing corneal topography maps for right eye (RE) and left eye (LE)]
High order aberrations

Ocular aberrations

RE

Ocular aberrations

LE
RK Case 2

Axial Diopters

Corneal Topography

SIM K’s
40.78 D @ 80°
39.81 D @ 170°

SIM K’s
41.85 D @ 87°
40.20 D @ 177°
Radial keratometry

- Spherical aberration
- Flattening over each incision
- Many incisions blend into each other
- Tetrafoil or trefoil
- Markedly poorer optical quality with larger pupils
Post-graft astigmatism

- **Primary:** after removal of sutures
- **Secondary:** wound dehiscence, host thinning
Incise and suture vs. relaxing incisions
Relaxing incisions
± compression sutures
Post-graft astigmatism

Axial Diopters

Corneal Topography

Higher-order aberrations

Sph 5.04 D
Cyl -16.62 D
Axis 49°
LO RMS 15.85 μm
HO RMS 3.01 μm
TOT RMS 16.13 μm
Pupil 6.00 mm
RMS fit err 0.092 μm

ANSI Z80.28
RI + compression sutures
Change with RI + compression

Higher-order aberrations

Whole eye wavefront

- Sph: 6.15 D
- Cyl: -10.34 D
- Axis: 51°
- LO RMS: 9.58 μm
- HO RMS: 2.29 μm
- TOT RMS: 9.85 μm
- Pupil: 6.00 mm

ANSI Z80.28
Excise and suture

Host thinning 6 – 9 o’clock
Compare Axial Diopters
Discussion

- Incisions flatten
- Sutures steepen
- Coupling
- Astigmatism
- Symmetrical vs. asymmetrical treatments
- Typical: Coma, trefoil, tetrafoil
- More complex patterns also
Questions?