Commonly Encountered Corneal Ectatic Diseases

- Post-LASIK ectasia (PLE)
- Idiopathic ectasias (probable genetic etiology)
  - Keratoconus (KC): >5% of patients seeking refractive surgery have occult/forme fruste KC
  - Pellucid marginal degeneration (PMD): Very rare

Diagnostic Techniques

- Clinical Exam
- Topography
- Tomography
- Biomechanical tests
Post-LASIK corneal ectasia:
Incidence = 1/10,000 procedures

Post-LASIK corneal ectasia

- Usually due to undetected pre-op abnormalities, such as “forme-fruste keratoconus” (FFKC)
- Surgical complications:
  - Cornea too thin
  - Flap too thick
  - Too much tissue removed
  - Multiple “touch-ups” (esp. hyperopic ENH after myopic Rx)

Post-LASIK ectasia can also occur for NO good reason!

Keratoconus and Pellucid Degen.:
Area of maximal protrusion is ABOVE area of maximal thinning in PMD
Keratoconus: Point of maximum thinning = point of maximal protrusion

Early Keratoconus: Fleischer ring

Use of Cobalt blue light PRIOR to fluorescein is critical!

Keratoconus: Vogt striae (especially prominent after ctl removal)
Keratoconus: Advanced, with apical scarring

Pellucid Marginal Corneal Degeneration (PMD)
- Inferior thinning
- High, REGULAR against-the-rule astigmatism is most common initial manifestation
- Missed by most KC screening programs

Pellucid Marginal Degeneration:
- Bilateral, inferior thinning
- Frequently mis-diagnosed as high astigmatism or keratoconus

Pellucid Marginal Degeneration: Demographics
- 20-40 years old at presentation
- Usually present with high against-the-rule astigmatism
- Contact lens intolerance
- FREQUENTLY seek out refractive surgery
- FREQUENTLY missed by refractive surgeons: High incidence in ectasia cases
Corneal Topography: Digitization of Placido-Based Reflection

- “Industry standard”
- Precludes adequate analysis of far periphery
- Unable to obtain data from posterior cornea
- ORBscan subsequently utilized parallel segmental cross sectioning to study posterior surface but many “false positives”

“Atypical Inferior Steepening”: Keratoconus detection programs

ORBscan corneal imaging: “Posterior elevation”
ORBscan documents progressive Post-LASIK ectasia (PLE)

8 wks. post-op  16 wks.  32 wks.

Problems with the ORBscan
- High false-positive rate (especially in postsurgical/post-refractive surg. corneas)
- Any corneal opacities or irregularities give bad readings
- Unable to assess “thickness progression”

Elevation-Based Corneal Topography: Pentacam Tomography

“Scheimpflug” imaging device that utilizes 2 cameras:
- One monitors fixation and pupil
- The second one rotates to provide cross-sectional images

Pentacam

+ 3D Anterior Chamber Analyzer
+ Pachymetry Map
+ Topography Maps (ant. & post.)
+ Elevation Maps (ant. & post.)
+ 3D Cataract Analyzer
+ 3D pIOL simulation/aging prediction
+ Belin/Ambrosio Enhanced Ectasia
+ Holladay Report
+ Tomography
Pellucid Marginal Degeneration: Classically diagnosed if “inverted horseshoe” or “crab’s claw” sign noted on topography.

Belin and Ambrosio: “Over-diagnosis” of PMD with topog.
Pellucid Degeneration: Pachymetry map shows progressive inferior thinning

Wavefront analysis: “Automated retinoscope” - measures ALL aberrations

The Value of Wavefront Analysis + Pentacam: Patient “G.G.” - ? Unilateral KC

5/03: 18 y.o.c/o blurry Va OS
MR OD= -0.50 sph
OS= -0.75 + 1.75 x 10
Central pachs= 0.566mm OU
No iron lines/rings
“G.G.” TMS OD- normal
OS- Assymmetric inferior steepening

G.G.: Pentacam posterior elevation
OD: Normal          OS: Keratoconus/PMD

GG: Zywave wavefront OD-normal
OS- Significant “HOA’s”

FFKC (Occult KC)/Pellucid
• Refractive surgery contraindicated at present
• Surprisingly common
• Missed by topographic “keratoconus detection programs”
• Role for wavefront analysis? Not all systems are equally helpful but HOA’s suspicious
• Role for Pentacam- Synergistic with wavefront
Pentacam for KC detection:

- Graphic plot of mean corneal thickness, concentrically, as a function of diameter
- Indices: ISV, IVA, KI, CKI, Rmin, IHA, IHD
- Belin-Ambrosio ectasia Detection:
  - “BAD” program
- MUCH more sensitive and specific than topography alone

ORBscan frequently indicates “false positive” post-LASIK ectasia

Pentacam of previous case:
No ectasia

Post-LASIK ectasia Pentacam:
Thinnest point=Steepest point
Normal astigmatic cornea

Keratoconus Pentacam: “posterior elevation”

PMD: Normal horiz/Abn. vert
Pachymetry map inf. thin

Keratoconic vs normal but thin cornea: Scheimpflug photo
Possible FFKC on topography: Atypical inferior steepening

Known keratoconus in OS only: KC detection programs negative OD

“BAD” plots for previous patient: OD really IS normal!

Pentacams of previous case: Normal OU- no “FFKC”
### Biomechanical tests for ectasia

- Ocular Response Analyzer (ORA, Reichert)
- Corvis (Oculus) - Not yet approved by FDA,

### Treatment options available for patients with corneal ectasia in the U.S.

- Penetrating keratoplasty
- Deep lamellar keratoplasty
- INTACS
- Corneal collagen crosslinking (CXL)
- Excimer laser PTK
- Phakic IOL’s
- Combination strategies

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### Corneal Ectasia: Traditional Management

- Contact lenses
- Penetrating keratoplasty if contact lens intolerant or inadequate best-corrected acuity with contacts

### Penetrating Keratoplasty: Full-thickness tissue replacement
Classic “combined technique”-
12 interrupted sutures + overlying running
Interrupted sutures removed sequentially

“Running only suture” closure:
Stays in for years but can be “adjusted” in
the office for astigmatism management

The “adjustable running suture”
Described by Jim McNeill, MD- Loma Linda CA

Adjustment of suture at slit lamp
with ROUNDED (Tennant) forceps:
Ideally 1-2 months post-op
Suture adjustment strategy

Adjustable running suture:

Advantages
- Faster surgery
- Faster visual recovery - less irregular astigmatism
- Easier follow-up
- Fewer suture-related complications

Disadvantages
- Patient cooperation is critical
- Suture can break during adjustment
- Wound is opened up in early post-op period
  - Potential infection
  - Potential wound dehiscence

Penetrating Keratoplasty:

Disadvantages
- Intraocular surgery, with its attendant risks:
  - Endophthalmitis
  - Cataract formation
  - CME, RD, etc.
- Endothelial rejection
- Lifelong risk of trauma
Partial thickness transplant:
"DALK"
- Less invasive
- Preserves the patient’s endothelium
- Few rejection issues
- Less susceptible to rupture
- Starts with “big bubble”
- Femto-assisted?

"DALK" for Keratoconus: Mechanism

Pre-op:
- Protrusion

Post-op:
- Flattening similar to P.K.

DALK for Keratoconus
DALK complications
Up to 50% incidence

• Intra-operative:
  – Difficulty obtaining “big bubble”
  – Inadvertent a.c. entry/conversion to PK
• Post-operative:
  – Detachment/double a.c.
  – Regular astigmatism
  – Irregular astigmatism

INTACS

• FDA approved for myopia
• Overtaken by LASIK
• Revived as Rx for keratoconus by Joseph Colin, MD, Bordeaux FRANCE
• Addition Technologies, Des Plaines IL

Another Option for Keratoconus

INTACS Patients

- Steep K < 60D
- Minimal apical opacity
- Contact lens intolerant/inadequate
  - Outright failure
  - Shortened wearing time
  - Inability to achieve 20/40
  - Desire to forestall central scarring
- Apprehensive about PK and interested in ALTERNATIVE Rx (like MANY KC patients)!
- Willing to wear TORIC scl post-op
**How INTACS Work…**

- Placed at 75% corneal depth
- Separate corneal lamellae
- Separation shortens corneal arc length
- Central cornea flattens
- Increased flattening achieved with thicker segments
- (Newer “INTACS SK” available outside of USA - larger)

**INTACS implantation facilitated by Intralase “channel creation”**

- Dramatic improvement in safety and efficacy
- Increased expense and complexity

**Femtosecond laser INTACS insertion**
(Courtesy Sonia Yoo, MD, Bascom Palmer Eye Inst., Miami FL)

**Scheimpflug imaging of INTACS in situ**
- Pre-op
- Post-op
Good Procedure Outcome:

**Pre-Op**
- UCVA 20/200
- MR: $-4.75 + 5.25 \times 005 = 20/40$
- RGP intolerant

**Post-Op (Day #1)**
- UCVA 20/50++
- MR: $-1.00 + 2.75 \times 150 = 20/20$
- Soft Toric provides good Va

Courtesy David Schanzlin, MD, San Diego CA

Problems with INTACS

- Financial/Reimbursement
  - Sometimes insurance covers them
  - Major pre-certification hassles

- Patient expectations
  - They still have to wear contacts - may be hard to fit
  - BCVa may not be as good as desired

- Complications
  - Extrusion, migration, etc

INTACS migration

Collagen Cross-linking (CXL)
For Corneal Ectasia

INVESTIGATIONAL in the USA-
For the treatment of corneal ectatic conditions
(NOT approved by FDA)

Primary purpose: Stop progression of KC
Secondary gains: Improved vision and contact lens tolerance
How Cross-Linking Works

Diabetics rarely develop keratoconus.

Theorized that this may be because of “natural cross-linking” from high glucose and UV light exposure.

“Cross-links” between collagen fibers add strength to the cornea

Seiler T, Huhle S, Spoerl E, Manifest Diabetes and Keratoconus, Graefe’s Arch 2000

Corneal Collagen Cross-Linking

Creates chemical bonds between fibers

Cross-Linking is Not New

• Hardening of polymers in materials science since 1930s
• Dentists cross-linked for decades
• Normal aging of connective tissue involves cross-linking and stiffening
• ↓ Progression of KCN with age as natural crosslinking↑
CXL is based upon bona-fide scientific lab investigation

- Various chemicals were tested in vitro
- Pioneers: Wollensak, Spoerl, Seiler, and Mrochen. Initially in Dresden, GERMANY, now in Zurich, SWITZERLAND.

Riboflavin found to yield optimal strength

Riboflavin/Ultraviolet-A–induced Collagen Crosslinking for the Treatment of Keratoconus

GREGOR WOLLENSAK, MD, EBERHARD SPOERL, PhD, AND THEO SEILER, PhD, MD

AJO, 2003
Rigidity= 329% increase
Safety of Cross-Linking - if cornea is saturated with Riboflavin:

**Endothelial Damage threshold**

<table>
<thead>
<tr>
<th>Thickness (μm)</th>
<th>Risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>100</td>
<td>50%</td>
</tr>
<tr>
<td>200</td>
<td>25%</td>
</tr>
<tr>
<td>300</td>
<td>12%</td>
</tr>
<tr>
<td>400</td>
<td>6%</td>
</tr>
<tr>
<td>500</td>
<td>3%</td>
</tr>
<tr>
<td>600</td>
<td>2%</td>
</tr>
</tbody>
</table>

3.00 mW/cm²

1.49 mW/cm²

0.74 mW/cm²

0.36 mW/cm²

0.18 mW/cm²

0.09 mW/cm²

0.06 mW/cm²

The “Dresden Protocol”: Seiler et. al

Remove epithelium
- 30 min riboflavin
- 30 min UV
- 3.0 mW/cm²

These numbers were based on approximations.

*Seiler T. and Mrochen, M, Personal Communications, 2010,11

Typical “Epi-Off” CXL Early Clinical Course

- **Worse** vision for 3-6 months
- **Steeper** Ks
- More compact corneas
- Some haze

Classic CXL: Amoils brush epi. removal

[Image of CXL procedure]
Typical Epi-Off CXL: Post-op Day #3

“Long-term results of CXL in Italy”
Caporossi, et. al., AJO 2010

Refractive results:
+2.2D at 4 years

Central K vs. contralateral control

Vision 4 years post-op:
UCVA= +2.8 lines, BSCVA= +2 lines

+2.2D flattening after 2 years

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### Improvement in Corneal Regularity

**Aberrometry:**
Reduction of HOA’s

### Long-term Results of CXL

**Goldich, et al, Cornea 2012**

- 14 eyes of 14 patients, “standard technique”
- Follow-up > 2 years
- Mean K Flattening = - 2.4D
- Improvement in BCVA, decreased mean S.E.

Vinciguerra, et. al.: “2 year CXL results in patients younger than 18 with documented progressive KC” - Cornea 2012
- Improved UCVA, BCVA, HOA’s

### CXL complications are not common, even with “standard technique”

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polhammer M</td>
<td>CRS July 2008</td>
<td>1 Corneal Ulcer - E Coli</td>
</tr>
<tr>
<td>Romesh I</td>
<td>CRS March 2009</td>
<td>1 Sterile Infiltrate &amp; Melt</td>
</tr>
<tr>
<td>Kymionis G</td>
<td>CRS Nov 2007</td>
<td>1 HSV Keratitis</td>
</tr>
</tbody>
</table>

But, complications do occur………………..

### Delayed epithelialization, infiltrate after CXL

**Courtesy of W. Trattler, MD**
Complications from “standard” epi-off technique:

- Most, if not all, are related to debridement:
  - Persistent defects
  - Scarring
  - Infections
  - Melting
- This spurred interest in “Trans-epithelial CXL”

Not All Trans-epi CXL is the same-

Initial studies in Europe unsuccessful

- Dextran solution still used in all studies
- BAK, other permeability agents not used
**The Corneal Epithelium**

Barrier to riboflavin penetration into stroma?
Only in the DEXTRAN preparation.

**Trans-epithelial CXL: European results**

- Wollensak, JRS 2009: 20% of effect
  - But they used dextran preparation of riboflavin
- More recent studies show 80% of effect

**How many of these solutions require debridement for penetration?**

“Trans-epithelial CXL”
*Filippelo, M, O’Brart, et al: JCRS 2/12*

- Progressive KC- “Ricrolin TE”
- More superficial demarcation line noted
- Improvements in aberrations, UDVA, CDVA, and Topography
- No change in endothelial density
- “Non-invasive, useful in pediatrics, and in corneas with < 380u central thickness”
The “CXL-USA” Clinical Trial

• CXL is not FDA-approved in the USA
• CXL-USA is a registered clinical trial
• 16 sites in the USA
• All centers actively enrolling patients
• Our first treatments: April, 2010
• Rapid conversion to trans-epithelial CXL

CXL-USA Study: Inclusion criteria

• 8 years of age or older
• Keratoconus, FFKC, post-LASIK ectasia, pellucid degeneration
• Post- RK, with fluctuating vision
• Informed consent/study visits
• Minimum corneal thickness of at least 300u to enroll, 400u to treat
• > 6 months since last corneal surgery

CXLUSA

• Prospective Non-randomized Multicenter study evaluating:
  - Epi-On and Epi-Off CXL
    • Proprietary UV light Source
    • Locally compounded Riboflavin
    • Age 8 and over

Indications:
• Keratoconus
• FFKC
• Pellucid
• Post-LASIK ectasia

Exclusion criteria

• Corneal scarring that markedly affects vision
• Contraindications to the use of any study medications or their components
• Pregnancy or breast feeding
• Active herpetic corneal disease
• Inability to complete f/u visits

Investigators:
• Roy Rubinfeld, Chevy Chase, MD
• William Trattler, Charles Kaiser, Carlos Buznego: Miami, FL
• Parag Majmudar, Randy Epstein: Chicago, IL
• Doyle Sinhag: Atlanta, GA
• Lance Forstot, Erik Letko: Littleton, CO
• David Wallace, Jon Davidorf: John Hovanesian Los Angeles, CA
• Sandy Feldman: San Diego, CA
• Joel Luchs: Long Island, NY
• Jay Schwartz: Phoenix, AZ
• Ty McCall, Brad Bowman, Henry Gelander: Dallas, TX
• Dan Goodman: San Francisco, CA
• John Talamo, Kathryn Hatch: Boston, MA
• Gregg Nedy, Ranjan Mathewa: St. Louis, MO
• Audrey Talley Rostov, Mark Krontos: Seattle/Spokane, WA
• Bill Wiley, Shamik Bafna: Cleveland, OH
• Doyle Stulting, David Hardt; John Hovanesian: Atlanta, GA
• Lance Forstot, Erik Letko: Littleton, CO
• David Wallace, Jon Davidorf: John Hovanesian Los Angeles, CA
• Sandy Feldman: San Diego, CA
• Joel Luchs: Long Island, NY
• Jay Schwartz: Phoenix, AZ
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• Doyle Stulting, David Hardt, Sherman Reeves, Liz Davis: Minnesota, MN

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Protocol: Visit schedule

- 1 day
- 1 week (and then ok to resume ctl)
- 3 months
- 6 months
- Supplemental procedures OK after 6 months

Trans-Epithelial CXL: Technique Overview

- Anesthetic/BAK drops pre-op
- Hypotears pre-op
- Hypotonic riboflavin WITHOUT Dextran
- UV light for 30 min. after calibration
- “Fractionation” of light dose

Detailed protocol: Loading

- Riboflavin 0.1% (hypotonic, in sterile water) - obtained locally by each investigator
- No lid speculum during ribo loading
- Start with Hypotears (BAK) q min. x 6 min.
- Alternate riboflavin and proparacaine drops every minute for 45 min., at least

Riboflavin 0.1% drops for 45 minutes
Hypotonicity (in our formulation) facilitates penetration

- Corneal tissue = 380-420 mOsm
- Standard ribo-dextran (*prevents* corneal swelling and compacts the cornea) = 310-400 mOsm
- Hypotonic 0.1% ribo = 3.89 mOsm!!!

“Ricrolin-TE”
Hypotonic Riboflavin 0.1%
Currently available only outside of the U.S.

Protocol: Assessment of ribo loading

This is the most difficult part of the procedure.

Fully “loaded” after trans-epi riboflavin
Protocol: Verification of loading

- Check cornea after 30 min. of ribo drops
- Surgeon verifies that the stroma shows some significant green, relatively uniform staining and some A.C. flare
- The green stromal staining is subtle in trans-epi and much, much less bright green than with “standard” epithelial removal
- Then 30 min. more drops prior to Rx

Calibration of light exposure:
3 inches from cornea to light

Treatment Protocol: Fractionation
- Eyes open during UVA application.
- During “fractionation”, eyes may drift a bit when light is off. Patient re-fixates during the “light on” part of the duty cycle.
- Specula are used during light exposure.
- We do not USUALLY sedate our patients, but occasionally do give 10 mg Valium
- Riboflavin gtts q 5 min., proparacaine, BSS
370 nm UV-A light for 30 min.

Patient’s view of UV light

Bilateral treatments preferred by most pts.

Post-op Protocol

– It’s common to see some PEK on POD #1
– Routine use of BCL’s one night
– The eyes are comfortable the next morning, and vision is usually improved
– Topical NSAID x 48 hours
– FQ antibiotic, pred. gtts qid for 1 week
Clear cornea on POD #1 after Trans-Epi CXL

Post-op course

Slow improvement usually noted in:
- UCVa/BCVa
- MR, MR
- Anterior elevation (Pentacam difference maps critical)
- Ctl tolerability

CCC’s latest outcomes:

724 eyes with > 6 mos. f/u

- One eye with progression. No re-treatments yet.
- Mean K: Improved from 51.8D to 50.0D, (p<0.05)
- Mean BCVa: Improved from 20/50 to 20/40, (p<0.05)
- Most patients are MUCH more contact lens tolerant
- 8 eyes have undergone INTACS secondarily

Numerical data does not tell the whole story

- Analysis of Pentacam “anterior sagittal curvature” plots with “difference maps” are critical to demonstrate the effect of CXL
How Effective was CXL in this case?

56 yr old male with Keratoconus: Epi-On CXL OD

<table>
<thead>
<tr>
<th></th>
<th>Pre Op</th>
<th>6 months Post Op</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCVA</td>
<td>CF</td>
<td>100</td>
</tr>
<tr>
<td>BCVA</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Refraction</td>
<td>-7.75+0.75x150</td>
<td>-3.75 +1.50 x 180</td>
</tr>
</tbody>
</table>

Recent Presentations by the CXL-USA Study Group

- 9/11: ESCRS
- 10/11: AAO
- 4/12: ASCRS
- 5/12: ARVO
- 9/12: ESCRS
- 2013- ASCRS, AAO

Compliments of Dr. Ray Stein, BOCHNER Eye Institute, Toronto
CXL-USA Sub-Study

“Therapeutic indication”
- For infectious keratitis
  - Denver, CO
  - St. Louis, MO
  - Miami, FL
  - Los Angeles, CA

“Enhancement” procedures-
“What is the next step”?
- INTACS
- PTK/PRK
- Conductive Keratoplasty (CK)
- Phakic IOL’s
INTACS + CXL
=10D flattening
(CRST, 2005)

Trans-Epithelial CXL + INTACS

- Ertan, Karacal, Kamburoglu; Cornea 28:719, 2009
  - Asymmetric INTACS with thicker segment inferiorly
  - Trans-epi CXL with 0.1% ribo-dextran
- Improvement in BCVA = 3 lines
- Decrease in mean K = 2.22D
- 0.35D more flattening from cxl

“Riboflavin injection into the corneal channel for combined CXL and INTACS”
Kilic, Kamburoglu, Akinci; JCRS 38:878, 2012
- 131 eyes of 105 patients
- (Also administered trans-epithelial ribo)
- “Safe and effective” (no complications)
- No data /controls to assess/compare relative refractive impact

CXL + INTACS: Current Philosophy

- Reimbursement issues are complex: CXL is not covered by insurance, INTACS MAY be….
- See how well patients respond to CXL
- Re-fit with contacts
- Consider INTACS if contact lens intolerant
INTACS + CXL

- Our protocol has been amended to allow for simultaneous INTACS and CXL
- For now, we are doing INTACS 6 months after CXL, when necessary/desired
- A prospective European study, designed to determine the optimal sequence, was started by Dr. Colin

What does the future hold for CXL?
(What is being done outside of the US)?

"Topography-guided Transepithelial Surface Ablation Followed by CXL"
Stojanovic (Norway), JRS 26:145, 2010

- Using “custom algorithm”
- No progression noted
A.J. Kanellopoulos, MD
NYU, Athens

The “Athens Protocol”

Same day: PTK, topo-PRK c MMC, CXL

Topo-guided partial PRK

1- Topolyzer: Placido disc topography
2- Pentacam (Oculyzer)
3- Pentacam HD (Oculyzer II)
4- Vario (placido + pupil sensor + iris recognition + limbal landmarks)

Final treatment plan = partial myopic PRK and partial hyperopic PRK
Keratometric change over 24 mos. shows progressive flattening. Makes prediction of refractive correction challenging.

Some improvement in UCVA, dramatic improvement in BSCVA: 98% > 20/40

Complications of the “Athens Protocol”
Cho and Kanellopoulos, AAO 2011

Healing delay—day 4—ok on 1 month

PRK-like haze 1 year after, in heavy sunbathing improved with steroids
The “Athens Protocol”:
Conclusions

• Not a refractive treatment—rather therapeutic
• The refractive result is unpredictable
• The improvement of BSCVA is very predictable
• Synergistic effect with CXL
• Minor complications dictate careful management
• No other current treatment can comparably improve topometric parameters (with long follow-up)

“Combined transepithelial PTK and CXL for progressive KC”

• T-PRK (n=18) vs mechanical debridement (n=19)
• Allegretto: 50u depth, 8.0 mm wide
• Refractive and visual *improvement* noted only in the PTK group.

Conductive keratoplasty followed by CXL in patients with keratoconus

• Kymionis, *Cornea* 29:239, 2010
• Effect is temporary even when followed by CXL
• Similar to concept being studied by AVEDRO

Avedro’s “Keraflex Vedera KXS” Microwave System

Peter Hersh, MD
CLEI Center for Keratoconus
Teanack, New Jersey
ICL’s for KC?

• Main problem HAS BEEN lack of FDA approval of TORIC ICL’s in USA
• FDA panel recommended approval on 3-16-14
• Can use after CXL, INTACS
• Cost issues (office vs O.R., etc.)
• Will have a major impact on KC Rx
• I have inserted them with Juan Batle, Santo Domingo

With Dr. Juan Batle-Santo Domingo, DR

Holcomb C3R ®: CXL followed by ICL, +/- INTACS: Boxer-Wachler
OS
Patient MJ
• UCVA Pre-op = CD
• OS = -11.00 - 3.00x50
• Operation date = 10-02-06
• OS = -0.50 - 0.50x20  20/40

OS
Patient VG
• UCVA Pre-op = 20/400 OU
• OS = -3.50 - 4.00x130
• Operation date OS = 22-06-07
• OS = PL - 1.00x160  20/25

Toric ICL’s for Keratoconus

• Best for mild cases, with good spectacle-corrected acuity
• Will be “Off-label” in USA

Why do almost ALL patients see better after CXL?

(Even with no objective “improvement” demonstrable with currently available technology)
Patients noted improvements in:
- Night driving, reading, monocular diplopia, glare, halo, starbursts, and FBS

No association with improvement in CDVA
Weak association with change in max. keratometry

\textit{(JCRS:38, 2012)}

\textbf{Quantitative Assessment of Corneal Biomechanics}

- Reichert “Ocular Response Analyzer” (ORA)-
  - Measures “corneal hysteresis”
- Oculus “CorVis” (not approved by FDA)
  - Tighter correlation with other parameters

\textbf{Does Trans-Epi CXL really work?}

\textbf{Trans-Epi CXL: Oculus “CorVis”}
(Red= pre-op, blue= post-op)

\textit{Courtesy of Dr. Renato Ambrosio, Rio de Janeiro, BRAZIL}
How does CXL improve contact lens tolerance?: *AJO*, 2/12

- Many prior studies have noted decreased sensitivity and improved ctl tolerance post-CXL
- This study showed less nerve damage after TE, but in both cases nerve changes WERE noted

Summary: CXL Patient Education

The “Keratoconus specialty practice”

- CXL definitely halts the progression of KC, and IS the “standard of care” outside of the U.S.
- We have an obligation to inform our patients
- Earlier treatment = better results
- Important to stress that patients will usually continue to require glasses or contact lenses
- Trans-epithelial CXL *significantly* expands potential patient pool by improving B/R ratio

Thanks for your attention!
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