Prevention and Management of LASIK Complications
David I. Geffen, OD, FAAO

Dry Eye
- Most common Complication

- Cause:
  - Disruption of corneal nerves = decreased tear production
  - Goblet cell damage from pressure during flap creation
  - Change in corneal curvature
    - Changes how the tear film covers the cornea
    - More significant in hyperopic treatments

Schallhorn N = 32,070

- Dry eye is the most common side-effect of LVC (11.3% at 3M)
- Symptoms are related to patient dissatisfaction
- There are predictive factors:

<table>
<thead>
<tr>
<th>Strongly predictive</th>
<th>Statistically significant, but little/no predictive contribution</th>
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<tbody>
<tr>
<td>Gender – Females</td>
<td>Age</td>
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<tr>
<td>Procedure type – PRK</td>
<td>TBUT</td>
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<td>Preop Rx – Hyperopia</td>
<td>SPK</td>
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<td>Ablation depth</td>
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<td>Flap type</td>
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Dry Eye & LASIK

- Pubmed Search yielded 164 citations
- Surprisingly few studies on risk factors or predicting post-op dry eye
- The majority were related to treatment of dry eye, editorials, reviews or to very specific issues such as hinge position

Dry Eye & LVC – Schallhorn

- Significant dry eye and ocular symptoms are rare 12 months after LASIK about 7% – representing a return to baseline
- Even at 12M, dry eye is related to procedure satisfaction
- Younger, lower hyperopes have the most dry eye complaints
- Older, higher hyperopes have the least dry eye complaints
**Dry Eye & LVC – Schallhorn**

- Age is not an independent predictor
- LASIK reduces the risk vs PRK
- Hyperopic females with dry eye symptoms before surgery and undergo PRK are at a much higher risk
- LASIK in asymptomatic hyperopic females reduces the risk
- Hyperopic males who undergo LASIK have a lower risk than the general population

**Dry Eye – Most common Complication**

- 85% at 1 week post-op
- 60% at 1 month post-op
- 11.3% at 3 months post-op
- 7% – Return to baseline by 12 months

2. Schallhorn – Optical Express Data

**Meibomitis**

- Reduce TBUT
- CL intolerance
- Azasite bid applied to lid margins
- Doxycycline 20mg, 50mg, 100mg
- Rx 100mg bid RTO 4–6 weeks
- If better 100 mg qd RTO 4–6 week

**Dry Eye Pre–treatment**

- Modify environment, medications, habits
- Artificial tears – drops, gels, ointments
- Topical Cyclosporin
- Topical Steroids
- Oral Doxycycline
- Nutritional supplements
- Punctal occlusion
- Meibomian gland manipulation

**Dry Eye Pre–treatment Goal**

- Minimal Symptoms
- No SPK
- Stable refraction
- Stable aberrometry
- Stable topography

**RS**

- 31 year old male
- 12 hours S/P uneventful LASIK OU
- Patient phones with complaints of discomfort

“My right eye became very uncomfortable about an hour after I got home and the vision is much better currently in my left eye.”
What do you tell patient

1. Go back to sleep the eye should feel better in the morning
2. Take another vicodin, that should help the pain
3. RTO now
4. Lubricate your eye and we will check you in the AM

LASIK What to Look for at Each Post Op

- LASIK Post Op Examination:
  - Flap:
    - Position: excellent, dislodged, striae, centered?
    - Clarity: clear, edema, haze?
    - Interface: clear, opacities, epithelial ingrowth?
    - Edges: smooth, rolled, eroded?
  - Interface Material
    - Debris
    - Epithelial cells/ingrowth
    - Diffuse Lamellar Keratitis (SOS)

Day 1

S/P myopic Lasik
UCVA  OD  20/30
     OS  20/20

Slit Lamp Evaluation
OD SPK central 1–2+
OS SPK inferior trace

What do you tell the patient?
What is the treatment?

What is the treatment

A. Increase artificial tears PF q1h OU
B. Add Restasis bid OU (if not already)
C. Discontinue the steroid
D. Collagen punctal occlusion

What do you tell the patient

A. You have a complication, both eyes are dry
B. Older patients always have dry eyes
C. The dryness is causing your vision to fluctuate
D. All patients have some dryness as they heal from LASIK surgery, lets increase your artificial tears to q1h and see you back in 72 hrs

Day One Pearls – Critical Timing

CLINICAL TESTS
- Celebration!!
- History
- UCVA OD/OS
- Slit lamp
  Biomicroscopy
- Review drops / instructions
- RTO 3–5 days

CLINICAL FINDINGS
- Dislodged flap
- Flap Striae
- Infiltrate/Infection
- DLK “SOS”
- SPK
- Poor UCVA

* Return to Surgery Center
7–15 Days Pearls – Critical Timing

**CLINICAL TESTS**
- History
- UCVA OD/OS
- Dry Refraction: BCVA
  - Only if UCVA < 20/20
- Slit lamp Biomicroscopy NaFl if indicated
- Instructions/Discontinue medications
- Patient reassurance
- RTO 3 weeks
- Resume most activities and make-up

**CLINICAL FINDINGS**
- Flap Striae
- DLK “SOS”
- Infiltrate/Infection
- Epithelial ingrowth
- SPK
- Refractive error
- Loss of BCVA*

* Return to Surgery Center

3,6,12 Month Post-op Pearls

**CLINICAL TESTS**
- History
- UCVA OD/OS
- Dry Rx BCVA at 3 month only (nomogram)
- Slit lamp biomicroscopy
- Instructions, RTO 3–6 months

**CLINICAL FINDINGS**
- Epithelial ingrowth
- SPK
- Refractive error
- Flap Striae
- Loss of BCVA*

*Return to Surgery Center

4–6 Weeks Pearls – Critical Timing

**CLINICAL TESTS**
- History
- UCVA OD/OS
- Dry Rx BCVA only if UCVA < 20/20
- Slit lamp Biomicroscopy
- Instructions, RTO 2 months

**CLINICAL FINDINGS**
- Flap Striae
- Epithelial ingrowth
- SPK
- Refractive error
- Loss of BCVA*

* Return to Surgery Center

Subconjunctival Hemorrhages
common findings on the 1 day post op LASIK patient

Epithelial Defect

Interface Debris
Interface Debris


Neither are permanent
Neither cause a visual problem

Watch for...

Wrinkling of the flap
Epithelial ingrowth
Diffuse Lamellar Keratitis (DLK) Stage 4

Bacterial keratitis
Post-Lasik/PRK: Consider Fortified Vancomycin

Patient SB

› 31 year old male
› 12 hours S/P uneventful LASIK OU
› Patient phones with complaints of discomfort OD
› “My right eye became very uncomfortable about an hour after I got home and the vision is much better currently in my left eye.”

When should patient RS return to the clinic?

› Immediately
› Diagnosis: Wrinkled/Dislodged/Slipped Flap
› Plan:
  • Return to surgeon to lift and smooth flap
  • Can temporarily place a bandage contact on the eye

Patient AB

› 25 year old female
› 1 week S/P bilateral LASIK
› Painless reduced VA in left eye since surgery
› “My vision just isn’t as good out of my left eye as I hoped it would be. I am seeing a lot of glare at night.”
What test would you perform on patient AB at the 1 week post op visit?

A. UCVA OD and OS
B. Refraction and BCVA OD and OS
C. Slit lamp biomicroscopy
D. Tonometry
E. Dilate pupil
F. NaFl instillation

Differential Diagnosis

- Flap Striae
- SPK/DES
- Residual refractive error
- DLK
- Infection (expect pain)
- Epithelial ingrowth (rare at 1 week)

Flap Microstriae

- Flourescein makes it easier to see as valleys and mountains differentiate with negative staining

Striae

Easier to see in retroillumination over the pupil
Flap Microstriae
- Often not visible at 1–day check
- Onset 24–72 hours
- Will NOT resolve without treatment
- Common with high myopia
- Common with deep ablations
- Usually find small amounts of mixed astigmatism
- Only significant if have a loss of BCVA or a subjective complaint in the quality of vision (night glare/halo)

Causal Factors: Flap Microstriae
- Flap Thickness
- Depth of Ablation
- Inflammation–DLK
- Epithelial Defects
- Surface Desiccation
- Trauma
- Smokers

Treatment
- If treatment is necessary: flap lift and stretch
- The sooner the better

Therapeutic Modalities
- Caro ball smoothing
- Flap Lift and Stretch
- Flap Lift with Epithelial Debridement/hypotonic saline
- Flap Suture
- Therapeutic PTK

Flap Striae
- Management– First approach
  - Weck Cell smoothing at Slit–Lamp
  - Follow with Bandage CL
- Next Steps
  - Back to operating microscope – lift and float
  - Stretch and smooth – Bandage CL
  - “Ironing” of flap with warmed spatula
  - Stretch and suturing flap
  - Debridement / PTK / PRK

Flap Striae
- CAUTION
  - 2–week window for best results
  - Have to be vigilant with less than great visual results
- Patient Factors
  - Eyelid “Squeezers”, “Rubbers”, “Itching” needs to be addressed.
  - Those who don’t like drops also need special instructions
Patient MN

- 25YOM 2 days s/p bilateral Lasik
- “My right eye hurts and is sensitive to the light. My vision is getting blurry in the right eye. My left eye feels fine.”
- When should you see this patient?
  - Immediately

Plan:

- Call your Refractive Surgery Center!!!
- Increase antibiotic (q1h)
- Add fortified antibiotic (Vancomycin)
- D/C Steroid
- Lift flap and culture
- Follow daily until resolution
  - (1–2 visits per day)
- Long-term
  - Flap smoothing
  - PTK
  - Flap removal
  - PK

Patient TS

- 42 year old male
- Right eye is sore to the touch since LASIK enhancement 1 month ago
- Vision has declined in the right eye over the past week
What tests would you perform on TS at the 1 month PO visit?
A. UCVA in OD and OS
B. Refraction and BCVA in OD and OS
C. Slit lamp biomicroscopy OU
D. NaFl instillation OU
E. Tonometry OU (only if necessary)
F. Corneal topography OU (only if necessary)
G. Wavefront Aberrometry (only if necessary)

Diagnosis?
- Epithelial ingrowth

One Month Ingrowth

Significant Ingrowth

What are good reasons to treat Epithelial ingrowth?
- Epithelial cells within pupil with decreased BCVA
- Persistent flap edge staining with NaFl
- Progressive refraction or topographic changes
- Flap melt
- Persistent sore eye
- Day time glare symptoms

The majority of epi ingrowth does not need to be treated
Why would FLS Provide Less Epi-Ingrowth than Blades?

- Bladed microkeratomes all have a tapered or gradual entry into the cornea.
- All FLS cases had either a 65 or 70 degree side cut from the lamellar dissection to the anterior surface of the cornea.

Conclusions

- There is significantly less epi-ingrowth with LASIK enhancements if the original LASIK was done with Intralase compared to mechanical microkeratomes.
- Some patients may be predisposed to have epi-ingrowth with enhancements.

Patient CC

- 40 year old female
- S/P bilateral LASIK x 1 week
- Patient reports a mild scratchy feeling that is getting worse.
- Slitlamp biomicroscopy reveals “cloudy haze in right cornea”

Diffuse Lamellar Keratitis (DLK)

- Begins in the periphery in the flap interface
- Looks like white “sand” particles
- Typically unilateral
- Tend to occur in outbreaks/sequential patients
- Looks like whitish sand underneath the flap
- Typically noted at day 1 or week 1 postoperative exams
- Can have late onset
  - Even years later, particularly after corneal trauma
Diffuse Lamellar Keratitis (DLK)

- **Etiology: Unknown?**
  - Bacterial endotoxins in the autoclave reservoirs
  - Contaminated sterilizer reservoir
  - Excessive corneal manipulation
  - Mold or fungal contamination
  - Trauma
  - Excessive Intralase energy (Unlikely with current Intralase)
  - Poor manufactured blades (Rarely used anymore)

- DLK is much less common now due to disposable instruments and Intralase.

### Grade 1 DLK

- **Signs/Symptoms**
  - Focal, white/gray, granular material in the flap interface
  - Normal VA

- **Treatment**
  - Increase topical steroids q1h
  - Follow up every 1–3 days
  - Taper steroid slowly (2–3 weeks)

- **Prognosis**
  - Excellent

- *Mild DLK may look similar to SPK, but SPK is on the surface and will stain with NaFL.*
- *Please report all DLK cases to your surgery center.*

### Grade 2 DLK

- **Signs/Symptoms**
  - Diffuse, white/gray, granular material in the flap interface
  - Normal VA or reduced 1–2 lines
  - Mild discomfort

- **Treatment**
  - Increase topical steroids q1h
  - Interface irrigation (return to surgeon)
  - Follow up every day

- **Prognosis**
  - Excellent after interface irrigation

- *IOP must be closely monitored during steroid treatment*
- *If IOP ↑ Change to a “softer” steroid and add Glaucoma medications*
- *Steroids are not discontinued*

### Grade 3 DLK

- **Signs/Symptoms**
  - Diffuse, confluent, white/gray, granular material in the flap interface
  - Significantly reduced BCVA (hyperopic astigmatism)
  - Discomfort and possible conj injection

- **Treatment**
  - Should not get to this stage
  - Increase topical steroids q1h
  - Interface irrigation!! (return to surgeon)
  - Follow up every day

- **Prognosis**
  - Good after interface irrigation
Grade 4 DLK

<table>
<thead>
<tr>
<th>Signs/Symptoms</th>
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<tr>
<td>• Diffuse, confluent, white/gray, granular material in the flap interface</td>
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<tr>
<td>• Intense central inflammation</td>
</tr>
<tr>
<td>• Significantly reduced BCVA (hyperopic astigmatism)</td>
</tr>
<tr>
<td>• Discomfort and possible conj injection</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Treatment</th>
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<tbody>
<tr>
<td>• Should not get to this stage!!!</td>
</tr>
<tr>
<td>• Increase topical steroids q1h</td>
</tr>
<tr>
<td>• Interface irrigation!! (return to surgeon)</td>
</tr>
<tr>
<td>• f/u every day</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Prognosis</th>
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<tbody>
<tr>
<td>• ?? Possible reduced BCVA, irregular astigmatism, residual hyperopia</td>
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PISK – Pressure Induced Steroid Keratitis

- Elevated IOP secondary to topical or oral steroids
- Looks Like DLK
- Can lead to aqueous fluid in flap interface
- False low IOP
- Scleral IOP

Interface Fluid Syndrome – IFS

**Diagnosis:**
- Interface is more ‘Smudgy’ than ‘dusted’ – like “frosted glass”
- Decreases vision more in early stages
- Fluid/Edema fills interface
  - Creates a “mini anterior chamber”
- IOP measures low

**Danger:**
- Iatrogenic steroid-induced glaucoma

Interface Fluid Syndrome – IFS

**Consider:**
- Careful evaluation of interface with optic section
- OCT if available on suspicious DLK patients
- Re-check of IOP in periphery
  - Rebound or TonoPen
- Discontinuing rather than increasing steroids if no initial response in a “DLK” presentation that is edematous rather than inflammatory in appearance
PRK Vision Expectations

- 20/40–20/80 Day 1
- 20/40–20/200 Days 2–4
- 20/30–20/80 Day 4–5
- VA rapidly improves 2–3 days after removal
  of BCL as epi thickens and smooths
- Functional Vision at day 5–6
  - Expect to have driving vision
- Good vision at 1 week to 10 days
- Excellent vision at 4–6 weeks
- Healed at 6 months

24 hours post PRK ≈ 15% healed

3–4 days post PRK ≈ 80–90% healed

Bandage Contact Lens:

- Remove when epithelium is 100% closed
  - usually at day 4–5
- If in doubt: leave BCL in additional 1–2 days
- Can remove BCL (carefully!!) reassess epithelium and then replace with new BCL if necessary
  - Caution: may increase pain and slow healing
  - Always use an antibiotic if replace the BCL
- Avoid removing BCL to simply change it for a fresh lens because it looks "dirty"
- Refit BCL if too loose causing physical discomfort or too tight – "Overwear Syndrome"
- Let patient know that VA immediately after BCL removal may be worse or no change

Re–epithelialization

- 99% of patients completely re–epithelialized by day 4 or 5

- If epithelium not healed at 72 hrs:
  - Consider Infection (MRSA) or Herpes Simplex
  - Continue to monitor daily
During Epithelial Healing
- Antibiotic & steroid until epithelium healed
- NSAID bid 2-4 days then D/C
- D/C antibiotic once epithelium is healed
- Topical anesthetic drops (only as an escape from pain, potentially can delay healing)
- Vitamin C 500mg bid

Steroid Taper:
- 4 x day for 1 week
- 3 x day for 1 week
- 2 x day for 1 week
- 1 x day for 1 week

Preservative Free Lubricants frequently

Post Op Visit Schedule:
- Daily, until the epithelium is filled in and the contact lens is removed
- 1-2 weeks after epithelium is healed
- Months 1, 3, 6,
- Enhancement if needed at 6 months or greater

Cold (Ice packs)
Topical NSAID
Topical Anesthetics*
Bandage Contact Lenses
Oral Medications
- NSAID
- Steroids
- Narcotics

Pain Cocktail (Off-label)
- 225 mg Naproxin Sodium
- 600mg Ibuprofen

1 Aleve + 3 Advil PO q8h
or
2 Aleve + 2 Advil PO q8h

Pregabalin – Lyrica
- Similar to Neurontin
- May have faster onset
- Schedule V
- 50mg, 75mg & 100mg CAPS
- Dosage 75mg q6h PO
Watch for...

- **Corneal haze**
  - Keratocytes become myofibroblasts to heal the corneal wound
  - Not transparent
  - Extra-cellular matrix is disorganized and denser which scatters light
  - Consider Vitamin C 500mg bid
  - Mitomycin C (MMC)
    - Allows for less haze
    - Developed as a chemotherapeutic agent
    - Acts to stop cells from proliferating by cross-linking DNA which modulates wound healing

Watch for .....Corneal Infection

Treat same as LASIK infection

Initial Over-Correction

- Common to start slightly overcorrected: +0.50–+1.25 and then glide into plano over 4–8 weeks
- Cylinder also very common during the first 4–6 weeks post-op
- Can use EW SCL (Night & Day) with the appropriate plus power to aid vision
- Decrease the use of Steroids

Keratoconus

- Keratoconus is a primary eye disease that results in a deformation of the cornea and loss of vision.
  - The cornea thins and becomes cone shaped
  - There is usually (Always??) a genetic basis.
  - Lots of theories about mechanism:
    - Tissue just weaker than normal, undergoes structural failure, which triggers many
    - There is an inability to handle oxidative stress in the cornea, due to congenitally abnormally enzymes, which causes oxidative damage, apoptosis, and so on
Keratoconus

- KC has a number of associated genetic or other conditions.
  - Down’s Syndrome
  - Atopy
  - Many others

- KC usually develops in adulthood
  - 35 is a common age of first presentation, but varies
  - It is possible for a patient to be perfectly normal at age 25 and have clinical KC at age 35.
  - Thus you should tell any young person this is possible and document it prior to refractive surgery.

Ectasia

- Ectasia is a clinical state that has the properties and course of Keratoconus, but occurs after refractive surgery
  - Most commonly, post Lasik
  - Has occurred with PRK and PTK
  - Many theories:
    - Some corneas are weaker than others
    - Some are destined to have KC
    - Some are due to Mechanical Inaccuracy (Flap too thick)
    - Surgery sets up an oxidative stress cascade, that in turn triggers KC.
    - Post PRK keratocyte apoptosis can be blocked by antioxidants.

Ectasia—Anatomical Basis

- Michael Smolek, Ph.D. of New Orleans has determined the structure of the cornea may explain why Ectasia is more likely after Lasik
  - Anterior Stroma is cross-linked
  - Posterior stroma is not

Ectasia—Prevention

- You cannot prevent every case of Ectasia
  - Inadequate knowledge
  - Pathophysiology
  - Properties of individual patient’s cornea

- Prevention is aimed at
  - Screen out susceptible patients
  - Planning surgery with “safe” parameters
  - Using alternatives to Lasik, when applicable.

HISTORY

- CHRONIC ALLERGIES—EYE RUBBING
- FAMILY HX—TRANSPLANT, KC
- REFRACTIVE STABILITY

EXAM

- DECREASED BSCVA
- REFRACTION—MYOPIA > 8D
- US CORNEAL PACHYMETRY
- RETINOSCOPY
- MANUAL K’S—IRREG, > 47
- WAVEFRONT—INCREASED COMA
- ORBSCAN/PENTACAM—POST FLOAT, THICKNESS GRADIENT
- ASSYMETRY BETWEEN EYES
- ENHANCEMENTS
Ectasia—Screening

- Other Things
  - Steep K: K>47 (Rabinowitz)
  - I/S ratio at 3.0 mm > 1.4
  - Add paracentral K inferiorly and superiorly
  - Divide the inferior total by superior total
  - Difference in K from Right to Left
  - High Myopia
    - <-9.0?
    - <-8.0?

Topography—a Comment

- Not every case of Asymmetrical Astigmatism relates to KC or Ectasia.
- Other causes include Displaced Corneal Apex or other forms of Misshaped Cornea.
- At least 50% are probably benign. you just don’t always know which 50%.
  However, the more the cylinder, the higher the suspicion.

Topography—a Comment

- Question: Which patient shows typical Asymmetric Astigmatism?

Rabinowizt

- Topography—the primary tool
  - Asymmetrical Astigmatism
    - AKA FFKC
    - "Smiley Face"
      Pellucid MD

- Normal presentation of astigmatism shows the bowtie to be completely symmetric.
Summary of Asymmetric Bowtie

Good
Bad
Dangerous

A Final Thought on Ectasia--

- If you do decide to operate on an eye with asymmetrical Bowties, always remember that all causes of this topographic picture are due to some irregularity or another.
- Thus, this is also an Indication for Custom Ablation

Ectasia—Alternatives to Laser

- PRK or similar
- Phakic IOL (ICL)
- Clear Lens Extraction
- Nothing is Always an Option

New Directions in Corneal Crosslinking

Corneal Collagen Crosslinking (AKA:Corneal Collagen Crosslinking, CCC, C3R, CXL, UV Crosslinking)

- Used to induce collagen crosslinking and increase corneal strength in the anterior stroma
- Keratoconus
- Post surgical Keratectasias

CXL Myths

- Wait till ectasia progresses before CXL
- People with KCN over 40 don’t progress
- Older patients don’t benefit from CXL
- Insurance will pay for CXL soon
- The epithelium must be removed for CXL
A Lasik Flap Weakens the Cornea by up to 30%

LASIK and Corneal Cross-linking Lasik XTRA

- International Studies
- Not Approved by FDA for use in US

Incorporating Lasik Xtra into Standard Lasik Surgery

1. Following excimer laser ablation in the flap bed, Avedro’s VibeX Riboflavin is applied to the flap bed for 1 minute.
2. The flap is repositioned.
3. The cornea is then illuminated with UVA for 1.25 minutes with the KXL System.

Thank You!