

Refractive Surgery
 Patient and Treatment Selection
 Karl Stonecipher, MD

Abbott Medical Optics C,L
 Alcon C,L,R
 Allergan C,L,R
 Alphaeon O
 Bausch and Lomb C,L
 Nidek C,L,R
 Presbia C,R
 Refocus C,L,R
 TLC E

C-Consultant/Advisor
 E-Employee
 L-Lecture/Travel Fees
 O-Owner/Equity
 P-Patents/Royalty
 R-Research

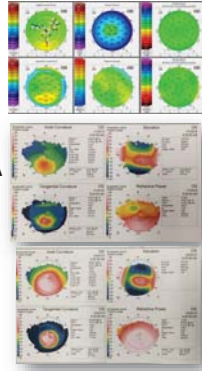
I need to acknowledge
 Dr. Bill Tullo and Dr. Lou
 Probst who provided
 slides for this talk.

Factor	PRK	LASEK	EPI-LASIK	LASIK
Range of correction	Low to moderately high			Low to moderately high
Postoperative pain	Mild to moderate 24-72 hours			Minimum 12 hours
Postoperative medications	1-3 months			1 week
Functional vision recovery	3 to 7 days			<24 hours
Refractive stability achieved	3 weeks to 3 months			1 week to 3 months
Specific complications	Haze formation, scarring	Haze formation, scarring	Haze formation, scarring, incomplete epithelial flap, stromal incursions	Free caps, incomplete pass of microkeratome, flap wrinkles, epithelial ingrowth, flap melt, interface debris, corneal ectasia, diffuse lamellar keratitis
Dry-eye sensitive	1 to 6 months			1 to 12 months
Thin corneas or wide pupils	Often not contraindicated			May be contraindicated depending on amount of intended correction
Special (relative) indications	Thin corneal pachymetry, wide scotopic pupil, LASIK complications in fellow eye, predisposition to trauma, keratoconus suspect (irregular astigmatism), glaucoma suspect, recurrent erosion syndrome, dry-eye syndrome, basement membrane disease			Concern about postoperative pain, requirement of rapid visual recovery
Special (relative) contraindications	Concern about postoperative pain, requirement of rapid visual recovery	Concern about postoperative pain, requirement of rapid visual recovery	Concern about postoperative pain, requirement of rapid visual recovery, glaucoma, scleral buckle, deep-set eyes, small palpebral fissure	Thin corneas, wide pupils, recurrent erosion syndrome, glaucoma, scleral buckle, deep-set eyes, small palpebral fissure

Surface Ablation Techniques. Suphi Taneri, MD, Michael Weisberg, MD, Dimitri T. Azar, MDJ Cataract Refract Surg 2011; 37:392-408 Q 2011 ASCRS and ESCRS

Contraindications for LASIK

- **Keratoconus**
 - Irregular Astigmatism
- **Monocular Patients**
 - Amblyopic patients must have BCVA 20/40 or better
- **Severe Dry Eye**
 - Exposure Keratopathy
- **Pacemaker**



Common Concerns

- **Pregnant/Breastfeeding**
 - 3 normal cycles and stable RX
- **Diabetes**
 - No retinopathy, stable RX, stable/low A1C
- **Autoimmune Conditions**
 - Concern about DES
 - Rheumatoid Arthritis = contraindication
- **HIV**
 - Need blood work

Common Concerns

- **Dry Eye**
 - No current symptoms, stable RX
- **Previous ocular Herpetic infection**
 - Some surgeons consider this an absolute contraindication
 - No occurrence for 6-12 months
 - Pre-treat with oral Acyclovir
- **Corneal Scar**
 - Consider PRK depending on placement
- **EBMD or Recurrent Corneal Erosion**
 - Consider PRK



Refractive Error

- Myopia
- Astigmatism
- Hyperopia
- Presbyopia



Myopia

FDA Approval

- LASIK: 1D – 14D
- PRK: 1D – 13D
- Intacs: 1D-3D
- ICL: 3D- 20D
- RLE/DLS: ANY

Common Use

- **LASIK: 1D – 8D**
- PRK: 1D – 6D
- Intacs: Not Used
- ICL: 8D- 26D
- RLE/DLS: ANY

Hyperopia

FDA Approval

- LASIK: 0.25D-6D
- PRK: 0.25D-6D
- Intacs: NONE
- ICL: NONE
- RLE/DLS: ANY

Common Use

- **LASIK: 0.25D-3D**
- PRK: 0.25D-3D
- Intacs: NONE
- ICL: NONE
- RLE/DLS: ANY

Myopic Astigmatism

FDA Approval

- LASIK: 0.25D-6D
- PRK: 0.25D-6D
- Intacs: NONE
- ICL: NONE
- CLE/DLS: 0.00D-6D

Common Use

- **LASIK: 0.25D-6D**
- PRK: 0.25D-3.00D
- Intacs: NONE
- ICL: NONE
- CLE/CAT: 0.75D-6D

Hyperopic Astigmatism

FDA Approval

- LASIK: 0.25D-6D
- PRK: 0.25D-6D
- Intacs: NONE
- ICL: NONE
- RLE/DLS: 0.75D-6D

Common Use

- **LASIK: 0.25D-3D**
- PRK: 0.25D-3D
- Intacs: NONE
- ICL: NONE
- RLE/DLS: 0.75D-6D

Mixed Astigmatism

FDA Approval

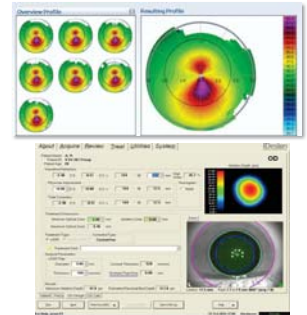
- LASIK: 0.75D-6D
- PRK: 0.75D-6D
- Intacs: NONE
- ICL: NONE
- RLE/DLS: 0.75D-6D

Common Use

- **LASIK: 0.75D-4D**
- PRK: 0.75D-4D
- Intacs: NONE
- P-IOL: NONE
- RLE/DLS: 0.75D-6D

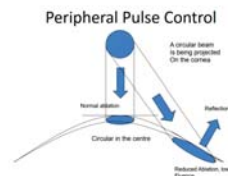
Types of Corneal Ablation

- **Contoura-Topographic Guided**
 - Uses patient's topography guide treatment
 - Treats corneal asymmetry and normal irregularities
 - Increase Quality of Vision
- **Wavefront Guided – Custom**
 - Uses patient's aberrometry to guide treatment
 - Induce less spherical aberration compared to conventional ablations
 - Increase Quality of Vision



Types of Corneal Ablation

- **Conventional Spherical treatment**
 - Induces significant spherical aberration
 - Rarely performed
- **Prolate – Wavefront-Optimized**
 - Age-related prolate pattern
 - Induce less spherical aberration compared to conventional ablations
 - Increase Quality of Vision



FDA Approved LASERS

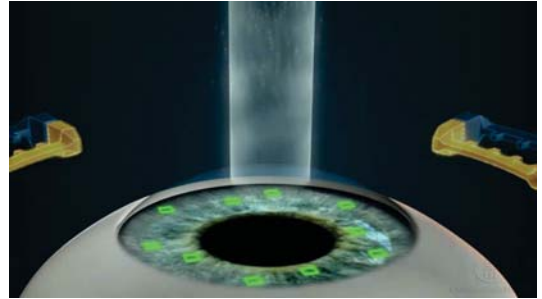
- Alcon – Allegretto
- B&L – Zyoptix
- AMO – VISX CustomVue
- Nidek – EC5000
- Zeiss- Meditec Mel 80



Alcon Refractive Surgery Suite



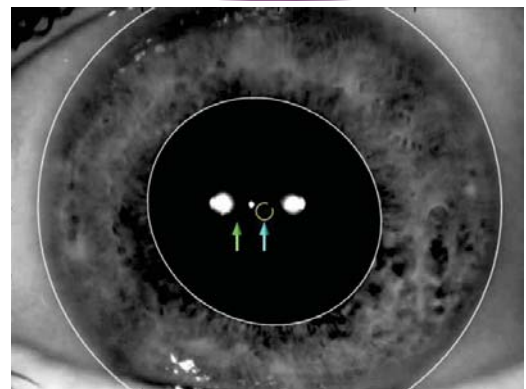
Iris Registration



VISX CustomVue Platform

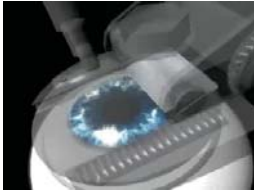


Pupil Centroid Shift



Mechanical Microkeratome

Still used in close to 40% of cases. I abandoned this technology in 2002 and never looked back.



-Kezirian G.K., Stonecipher, K.G. Comparison of the Intralase femtosecond laser and mechanical keratomes for LASIK. *J. Cataract and Refractive Surg.* 30(4): 803-810, 2004
 -Kezirian G. K., Stonecipher, K. G. Subjective Assessment of Mesopic Visual Function after LASIK. *Ophthalmology Clinics of North America*: 2004
 -Stonecipher K.G., Ignacio T.I., Stonecipher, MN Advances in Refractive Surgery: Microkeratome and femtosecond laser flap creation in relation to safety, efficacy, predictability, and biomechanical stability. *Current Medical Opinion*, 2006
 -Stonecipher, KG, Meyer, JJ, Stonecipher, MN, Felsted, DJ. Laser in situ keratomileusis flap complications and complication rates using mechanical microkeratomes versus femtosecond laser: Retrospective review; *Medical Research Archives*;2 (3), 10.18103/mra.v2i3.353,2015

Femtosecond LASIK Flap



Femtosecond Lasers

- Intralase
 - iFS
- Ziemer
 - LDV
- Femtec
 - 2010 Perfect Vision
- Zeiss
 - VisuMax
- Technolas
 - Victus



Intralase iFS



Comparison of Features: IntraLase® FS Laser and iFS™ Laser

IntraLase FS Laser

- ▶ Customization of all surgical parameters for circular flaps
- ▶ 15 to 20 second flap creation
- ▶ Clinical validation of biomechanical stability and wound healing
- ▶ Flap tensile strength 2x stronger than current microkeratome technology¹
- ▶ Clinically effective, extensively functional³
- ▶ Optimal predictability and reliability
- ▶ User friendly
- ▶ IEK feature optional

New iFS Laser

- Advanced customization of surgical parameters including:
 - Inverted side cut architecture
 - Elliptical shape
- Flap creation in <10 seconds
- Ability to biomechanically design every flap
- Flap tensile strength 3x stronger than current microkeratome technology²
- Contemporary, intuitive new GUI design
- Innovative hi-res digital surgical microscope
- IEK feature included

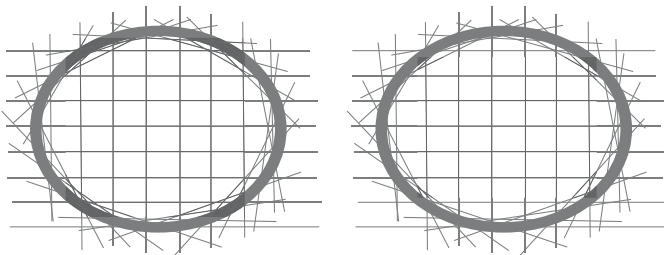
1. Kim JY, et al. A FS laser creates a stronger flap than a mechanical microkeratome. *Investigative Ophthalmology & Visual Science*, February 2006, Vol. 47, No. 2
2. Prof M Knorz, MD, Presented ASCRS 2008.
3. Durrie DS, Kezirian, GM: "Femtosecond Laser versus Mechanical Keratome Flaps in Wavefront-guided LASIK: A Prospective Contralateral Eye Study". *J Cat and Ref Surgery*.V31, Jan. 2005.

Corneal Nerves – Dry Eye



Elliptical Flaps

- Preserves peripheral vital lamellar fibers

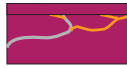


Dry Eyes

- ▶ Dry Eyes does not make any refractive procedure better.
 - ▶ But it *does* make them contact lens failures, thus more likely to seek treatment!
- ▶ Severe Dry Eyes is a contraindication to any corneal surgical procedure.
- ▶ Dry Eyes should be treated before any surgical procedure.

Dry Eyes

- ▶ ● After Lasik, this reflex arc is interrupted over much of the cornea by making the flap, which severs the nerves about 160 μ deep in the stroma.
- This causes a decreased tear flow until the nerves regenerate, which can take months



LASIK

Dry Eyes

- ▶ Partial return of innervation will imply only a partial restoration of tear volume.
 - ▶ If the tear volume is normal, the reserve tear production will be sufficient to maintain normal tear function
 - ▶ If the production of tears is borderline, the production of clinical dry eye syndrome by the surgery is possible, even likely.

Dry Eyes

- ▶ After the surgical procedure, the nerves began to regrow.
 - ▶ In PRK, the re-growth is usually complete within 3 months.
 - ▶ In Lasik, the re-innervation is frequently **not** complete at 6 months.
 - ▶ The return of innervation in Lasik is frequently incomplete.

Dry Eye

- ▶ Thus, it is **mandatory** that every refractive surgery be evaluated preoperatively by an effective technique.
- ▶ This normally would include some of the following:
 - ▶ Dry Eye Questionnaire
 - ▶ Rose Bengal and/or Lissamine Green Staining
 - ▶ Tear Break-up time
 - ▶ Schirmer's Test or Zone Quick
 - ▶ Tear Lactoferrin and Lysozyme Assay

Advantages of Femtosecond Flap

- Independent specific diameter
 - Independent specific thickness
 - Better flap centration
 - Variable hinge size/location
 - Beveled edge
 - Smooth evenly hydrated stromal bed
 - Conserve tissue
 - Planar shape
- **Safer**
 - Less complications
 - Less loss of BCVA
 - More gain of BCVA
 - Biomechanically stronger
 - Lower risk of keratectasia
 - **Better Efficacy**
 - Induce less HOA
 - Smoother beds
 - Even hydration
 - Faster visual recovery
 - Better Low Contrast vision

Patient's Experience

- Expectations for surgery day:
 - Mild oral sedative and numbing drops
 - Pressure feeling during flap creation
 - Vision may grey or black out
 - Burning smell 😬

Patient's Experience

- Key points to discuss with your patients:
 - Risk of enhancement
 - **Presbyopia**
 - Use of antibiotic and steroid
 - Reduce the risk of infection and inflammation
 - Dry eye

LASIK Post-Operative Care

- Patient Instructions during Post Op:
 - For 1 week -
 - No Swimming or using hot tubs
 - No Makeup
 - No Sports
 - No Rubbing or squeezing the eye (some say 1- 6 months)
 - Avoid dirty environments and wear sunglasses
 - Use the fox shield at night
 - Kick boxing and karate should wait 3 months
 - Scuba diving 1 month

LASIK Post-Operative Care

- TYPICAL MEDICATION REGIMEN:
 - Vigamox/Zymaxid qid X 1 week
 - Lotemax/FML/Pred Forte
 - q2h x 2 days
 - qid X 5-7 days
 - Artificial Tears qid X 1 month
 - Restasis bid when indicated
- Protection of the flaps
 - Fox shield QHS x 5-7 days
 - Sunglasses outdoors for 1 week
 - Limited physical activity

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)

LASIK Post-Operative Care

- POST-OP EXAM SCHEDULE
 - Day 1
 - Day 1-2 weeks
 - Months 1, 3, 6*, and 12*
- Enhancements:
 - Post op schedule the same as a primary procedure

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

*Notify surgeon

5-7 Days Pearls - Critical Timing

CLINICAL TESTS

- History
- UCVA OD/OS
- Dry Refraction: BCVA
 - Only if UCVA < 20/20
- Slit lamp Biomicroscopy
- 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*
- *Notify surgeon**

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***

***Notify surgeon**

Proprietary Information and Exclusive Property of TLCV

1 Month 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***
- * Notify surgeon**

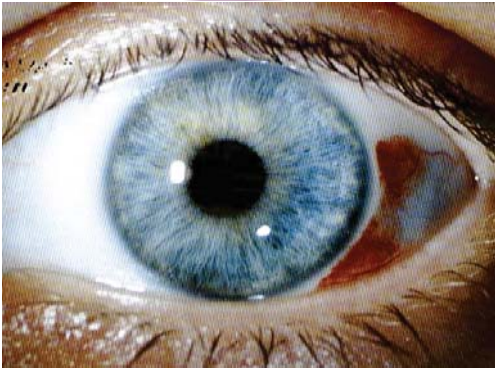
LASIK Post-Operative Care

- Common Early Clinical Findings:

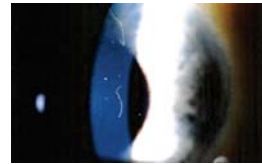
Visual recovery is quite rapid with LASIK – usually-

- 20/25 or better day 1
- VA varies with amount of myopic correction
- VA recovery is slower with Hyperopes
 - Takes one week to get to good VA, one month to get to great VA (similar to PRK)
 - Usually No "wow" effect on the 1 day post op.
- Age, refractive error, and ocular surface conditions will also contribute to the healing rate

Subconjunctival Hemorrhages



Interface Debris



Lint fibers under the flap will not cause an infection or visual problem. They will become inflamed during the 1st week from time to time, but don't have to be removed.

Epithelial Defect



Interface Debris



Red Blood Cells in the interface. Meibomian oil droplets in interface.

Neither are permanent

Neither cause a visual problem

Dry Eye Disease



Dry Eye – Most common Complication

- 85% at 1 week post-op¹
- 60% at 1 month post-op¹
- 11.3% at 3 months post-op²
- Return to baseline by 12 months³

1- Eric Polk, O.D., and Paul M. Karpecki, O.D. Review of Optometry, 9th Annual Dry Eye Report: Erase the Dryness after LASIK. Feb 2008
2- Schallhorn – Optical Express Data
3- Murakami, et al, Ophthalmology 2012

Dry Eye – Most common Complication

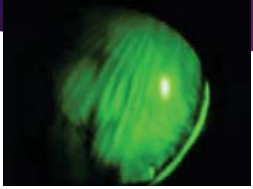
- Cause:
 - Disruption of corneal nerves = decreased tear production
 - Goblet cell damage from pressure during flap creation
 - Change in corneal curvature
 - Changes how the tear film covers the cornea
 - More significant in hyperopic treatments

Eric Polk, O.D., and Paul M. Karpecki, O.D. Review of Optometry, 9th Annual Dry Eye Report: Erase the Dryness after LASIK. Feb 2008

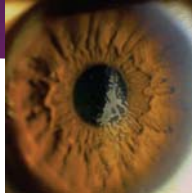
Dry Eye Treatment

- Artificial tears at least qid (1-6 months)
 - Patients present for post-op visits with a white conjunctiva and no signs of dryness, but they complain of blurry vision or halos and glare.
 - The patients are unaware of the irritation to the corneal surface because of the temporary neurotrophic effect of Lasik.
- Punctal occlusion
 - Extended duration collagen plugs
- Treat MGD
 - Best to pre-treat before surgery
 - Omega 3 Fish Oil vitamins
- Cyclosporine 0.05 % (Restasis)

Complications to watch for...



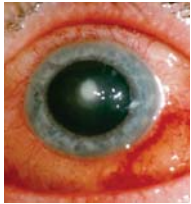
Wrinkling of the flap



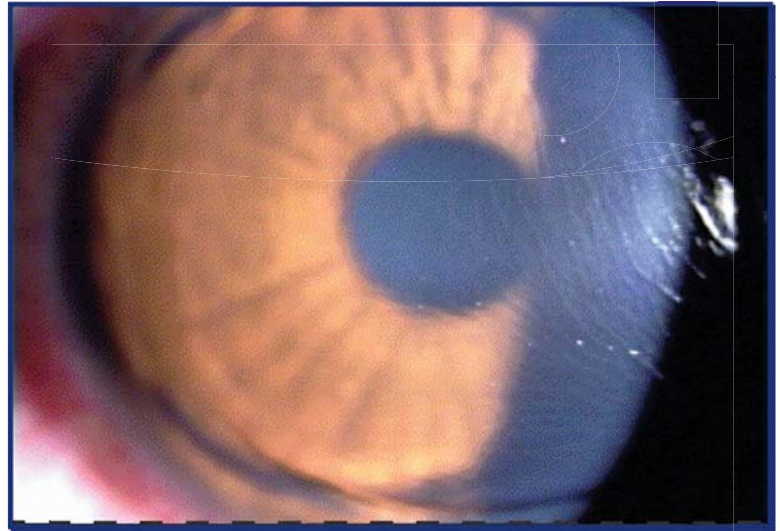
Epithelial ingrowth



Diffuse Lamellar Keratitis (DLK)
Stage 4



Bacterial keratitis
Post-Lasik/PRK: Consider Fortified
Vancomycin



Patient RS

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

Differential Diagnosis at 1 week

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

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. Fluorescein**

Flap Striae



Easier to see in retroillumination over the pupil



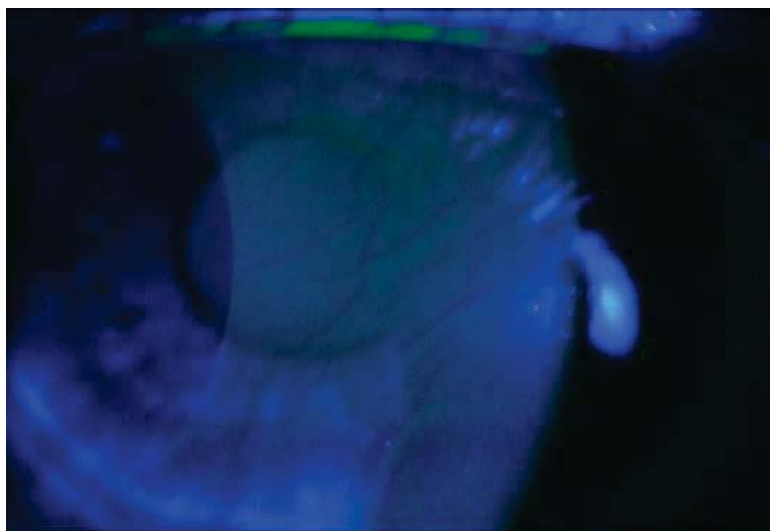
Flap Striae

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



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)**

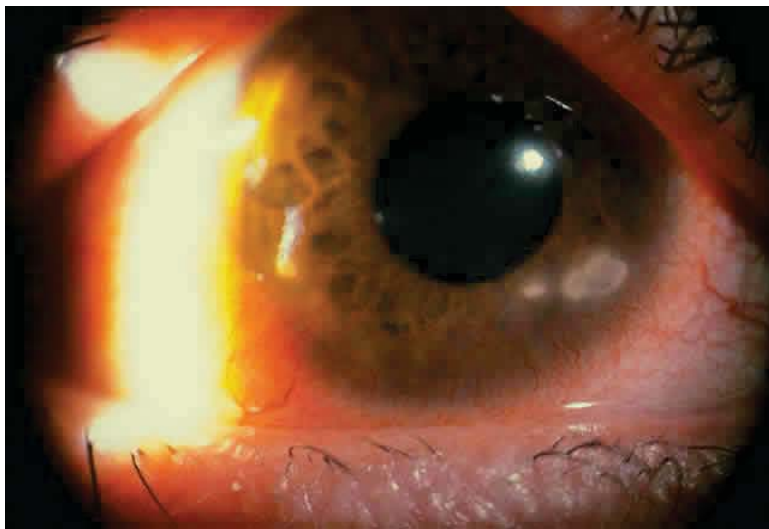
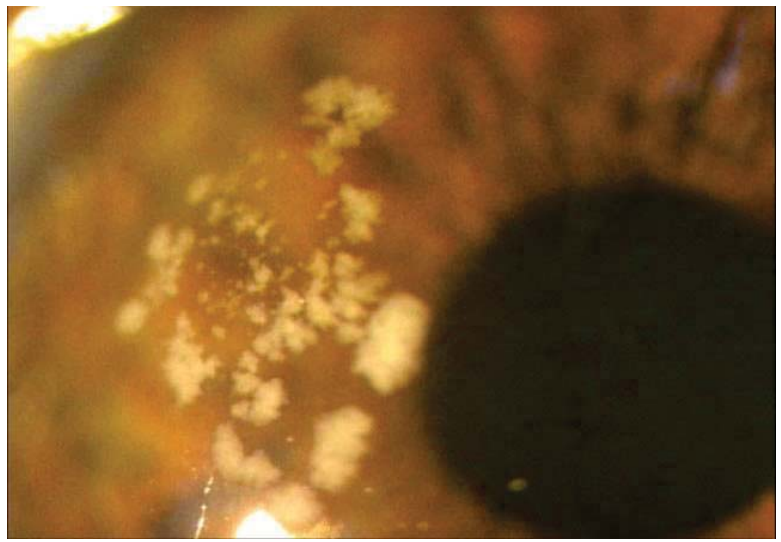


Flap Striae Treatment

- If treatment is necessary:
 - Caroball smoothing
 - Flap lift and stretch
 - Flap suture
 - Flap excision
- The sooner the better

Patient MN

- 25YOM 5 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



Hopefully never gets this bad...



Presumed Infectious Keratitis:

- Call your Refractive Surgery Center!!!
- Increase antibiotic (Zymaxid 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

What tests would you perform on TS at the 1month 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)

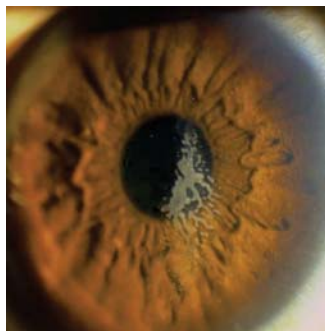
Patient TS

- 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



Diagnosis?

- Epithelial ingrowth



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”

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



Diffuse Lamellar Keratitis (DLK)

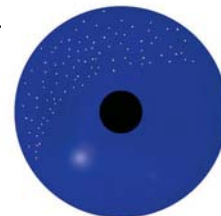
- Begins in the periphery in the flap interface
- Looks like white “sand” particles
- Typically unilateral
- Tend to occur in outbreaks/sequential patients
- Looks like whitish sand underneath the flap
- Typically noted at day 1 or week 1 postoperative exams
- Can have late onset
 - Even years later,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

DLK Grade 1

Signs/Symptoms	<ul style="list-style-type: none"> ▪ Focal, white/gray, granular material in the flap interface ▪ Normal VA
Treatment	<ul style="list-style-type: none"> ▪ Increase topical steroids q1h f/u every 1-3 days ▪ Taper steroid slowly (2-3 weeks)
Prognosis	<ul style="list-style-type: none"> ▪ 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.

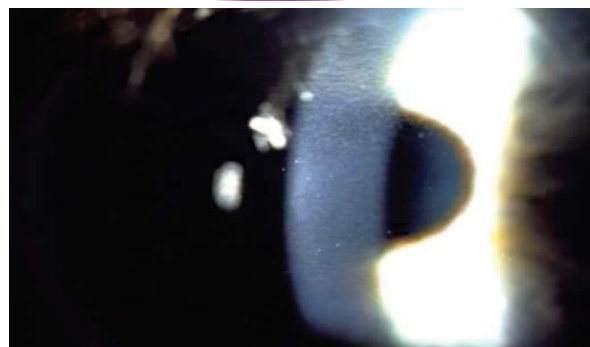


TLC Vision

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 proper sterilization and disposable instruments.

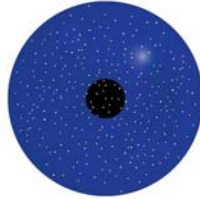
DLK Grade 1



DLK Grade 2

Signs/Symptoms	<ul style="list-style-type: none"> • Diffuse, white/gray, granular material in the flap interface • Normal VA or reduced 1-2 lines • Mild discomfort
Treatment	<ul style="list-style-type: none"> • Increase topical steroids q1h • Interface irrigation (return to surgeon) • f/u every day
Prognosis	<ul style="list-style-type: none"> • Excellent after interface irrig

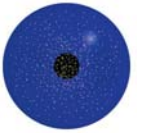
- IOP must be closely monitored during steroid treatment
- If IOP ↑ Change to a "softer" steroid and add Glaucoma medications
- **Steroids are not discontinued**



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DLK Grade 3

Signs/Symptoms	<ul style="list-style-type: none"> • Diffuse, confluent, white/gray, granular material in the flap interface • Significantly reduced BCVA (hyperopic astigmatism) • Discomfort and possible conj injection
Treatment	<ul style="list-style-type: none"> • Should not get to this stage • Increase topical steroids q1h • Interface irrigation!! (return to surgeon) • f/u every day
Prognosis	<ul style="list-style-type: none"> • Good after interface irrigation



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DLK Grade 2



DLK Grade 3



DLK Grade 4

Signs/ Symptoms	<ul style="list-style-type: none">Diffuse, confluent, white/gray, granular material in the flap interfaceIntense central inflammationSignificantly reduced BCVA (hyperopic astigmatism)Discomfort and possible conj injection
Treatment	<ul style="list-style-type: none">Should not get to this stage!!!Increase topical steroids q1hInterface irrigation!! (return to surgeon)f/u every day
Prognosis	?? Possible reduced BCVA, irregular astigmatism, residual hyperopia



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Thank You!

DLK Grade 4

