Photoablative Surgery Issues

Two very broad categories of post-surgical issues
Two very broad categories of post-surgical issues
Photoablative Surgery Issues

Optical Issues

Three basic ways you can have a suboptimal visual outcome
Three basic ways you can have a suboptimal visual outcome
What is the most common cause of overcorrection?
What is the most common cause of overcorrection?

Stromal moisture state
What is the most common cause of overcorrection?
Stromal dehydration
What is the most common cause of overcorrection?
Stromal dehydration

How does stromal dehydration lead to overcorrection?
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If the stroma is dehydrated, it ablates more readily, and thus more tissue is removed per laser burst
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What surgical factors are common causes of stromal dehydration?
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How does stromal dehydration lead to overcorrection?
If the stroma is dehydrated, it ablates more readily, and thus more tissue is removed per laser burst

What surgical factors are common causes of stromal dehydration?
--Allowing too much time to pass between denuding the epithelium/cutting the flap, and ablating the stroma
--Humidity and/or temperature in the excimer room being outside of the manufacturer’s recommendations
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If a pt is overcorrected, how soon should surgical correction be undertaken?
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If a pt is overcorrected, how soon should surgical correction be undertaken?
As many pts experience some degree of spontaneous regression over the first 3-6 months, it is prudent to allow several months to pass before intervening
What are the most common causes of undercorrection?

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--?
What are the most common causes of undercorrection?
--High degrees of pre-op myopia or hyperopia
--Spontaneous regression
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What steps can be taken to reduce or even reverse regression leading to undercorrection?
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--Use of MMC at the time of ablation
--Heavy topical steroid use in the post-op period if regression is noted to be ongoing
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If a pt is undercorrected, at what point should surgical correction be undertaken?
Once the refraction has stabilized, which usually takes at least # months
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If a pt is undercorrected, at what point should surgical correction be undertaken?
Once the refraction has stabilized, which usually takes at least 3 months
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What other complication, if present, should prompt the surgeon to wait even longer?
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Post-op haze—if present, it portends a higher risk for further regression and/or haze formation
**Photoablative Surgery Issues**

**Optical Issues**

- Overcorrection
- Undercorrection
- Aberrations

**What are the most common causes of undercorrection?**
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- Spontaneous regression

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Once the refraction has stabilized, which usually takes at least 3 months

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**Post-op haze**—if present, it portends a higher risk for further regression and/or haze formation. In such cases, the prudent course is to wait at least # to # months prior to re-treating.
Overcorrection

Undercorrection

Aberrations

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Once the refraction has stabilized, which usually takes at least 3 months

What other complication, if present, should prompt the surgeon to wait even longer?
Post-op haze—if present, it portends a higher risk for further regression and/or haze formation. In such cases, the prudent course is to wait at least 6-12 months prior to re-treating.
What factors are associated with the presence of post-op aberrations?
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--?
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What factors are associated with the presence of post-op aberrations?
--High degrees of pre-op myopia, hyperopia, or astigmatism
--A smaller ablation zone
--The presence of aberrations pre-op
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Which higher-order aberration is most contributory to pt symptoms?
What factors are associated with the presence of post-op aberrations?
--High degrees of pre-op myopia, hyperopia, or astigmatism
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Which higher-order aberration is most contributory to pt symptoms?
Spherical aberration
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Speaking of pt symptoms…Three tend to occur most frequently. What are they?
--Glare
--Haloes
--Ghost images
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Under what lighting condition are these more likely to occur?
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Speaking of pt symptoms…Three tend to occur most frequently. What are they?

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Under what lighting condition are these more likely to occur? Dim

Why are they more prevalent in dim lighting conditions?

Why would the edge of the ablation zone be particularly prone to producing aberrations?

Because the power of the cornea can shift markedly at the junction of treated and untreated cornea. This is especially true of hyperopic ablations, in which the midperiphery has been extensively ablated in order to steepen the central cornea.

What can be done to minimize the risk of this?

Creation of a 'blend zone' at the edge of the ablation so as not to have such an abrupt transition in corneal power.
What factors are associated with the presence of post-op aberrations?

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Most commonly, because the larger pupil size brings into play aberrations induced at the edge of the ablation zone

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Correction of hyperopia by steepening the central corneal optical zone and blending the periphery
Next we will look at \textbf{structural} post-op issues
Photoablative Surgery Issues

Structural Issues

Five non-visual problems you may encounter post-op
Photoablative Surgery Issues

Structural Issues

Central islands
Decentered ablations
Steroid-induced IOP elevation
Central toxic keratopathy
Infectious keratitis

Five non-visual problems you may encounter post-op
In this context, what is a central island?
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A small (<1 mm) area of elevation (at least 1D’s worth) within the area of flattening after myopic ablation.
Central island
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In terms of symptoms, how does a central island manifest?
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In terms of symptoms, how does a central island manifest?
As degraded central vision, which may include decreased acuity and monocular diplopia.
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Are central islands a common phenomenon?
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Not with current excimer technology, no
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Is the presence of a central island an indication for an immediate surgical revision?
Many will regress spontaneously, so no
What are common causes of a decentered ablation?
--?
--?
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What are common causes of a decentered ablation?
--Loss of fixation by the operative eye
--Poor pre-op head positioning by the surgeon
--Failure to ensure the operative eye is oriented perpendicular to the laser
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Hyperopic

Is decenteration more visually significant with myopic, or hyperopic ablations?
Hyperopic

Will decenteration regress spontaneously like a central island?
No, it must be addressed surgically
What is the main risk factor for steroid-induced IOP elevation?
What is the main risk factor for steroid-induced IOP elevation?
Use after surgery for a prolonged period of time
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Which class of procedure is at increased risk?
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Which class of procedure is at increased risk?
Surface ablation procedures
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Why surface procedures?
What is the main risk factor for steroid-induced IOP elevation?
Use after surgery for a prolonged period of time

Which class of procedure is at increased risk?
Surface ablation procedures

Why surface procedures?
Because steroids are often used for months afterwards to prevent haze formation
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Why is managing IOP after photoablative surgery especially challenging?
What is the main risk factor for steroid-induced IOP elevation?
Use after surgery for a prolonged period of time

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Why is managing IOP after photoablative surgery especially challenging?
Because altered corneal thickness and curvature renders applanation tonometry artifactually low. Fluid under a LASIK flap can do the same.
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Central islands
Decentered ablations
Steroid-induced IOP elevation
**Central toxic keratopathy**
Infectious keratitis

What is central toxic keratopathy?
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The development of acute, nonprogressive central corneal opacification in the immediate post-op period
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Is it rare, or common?
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Is it rare, or common?
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What is central toxic keratopathy?
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Is it rare, or common? Inflammatory, or noninflammatory?
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Is it rare, or common? Inflammatory, or noninflammatory?
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What is central toxic keratopathy?
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Is it rare, or common? Inflammatory, or noninflammatory?
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What is the cause?
What is central toxic keratopathy?
The development of acute, nonprogressive central corneal opacification in the immediate post-op period

Is it rare, or common? Inflammatory, or noninflammatory?
Rare. Noninflammatory.

What is the cause?
It is unknown as of this writing
**What is central toxic keratopathy?**
The development of acute, nonprogressive central corneal opacification in the immediate post-op period

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**In addition to haze formation, what other undesirable effect does it have?**
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It causes flattening of the anterior cornea, thereby producing a hyperopic shift
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**How is it treated?**
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It causes flattening of the anterior cornea, thereby producing a hyperopic shift

How is it treated?
Hypertonic solutions have been proposed, but their efficacy remains unproven
Which is more vulnerable to post-op infection—surface ablation, or LASIK?
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Surface ablation
Which is more vulnerable to post-op infection—surface ablation, or LASIK?
Surface ablation

Why are surface-based procedures at greater risk for infection?
Which is more vulnerable to post-op infection—surface ablation, or LASIK?
Surface ablation

Why are surface-based procedures at greater risk for infection?
Because the surgical technique involves creating a huge epi defect, thereby stripping the cornea of one of its primary defenses (ie, an intact epithelium)
Which is more vulnerable to post-op infection—surface ablation, or LASIK?
Surface ablation

Why are surface-based procedures at greater risk for infection?
Because the surgical technique involves creating a huge epi defect, thereby stripping the cornea of one of its primary defenses (ie, an intact epithelium). Further, post-op management of surface surgery involves BCLs as well as long-term steroid use, both of which further the risk of bacterial infection.
Which is more vulnerable to post-op infection—surface ablation, or LASIK?
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Infectious keratitis after LASIK
Photoablative Surgery Issues

Optical Issues

Structural Issues

Finally: We would be remiss if we didn’t at least mention one of the most common post-photoablative issues:
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Most pts return to their baseline tear-state by post-op month 6
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What is the typical course of photoablation-induced DES?
Most pts return to their baseline tear-state by post-op month 6

What is the most prudent way to address it?
Pre-operatively, by tuning up the pt’s ocular surface; and post-operatively, by treating it aggressively
What post-surgical maneuver after surface ablation puts the pt at increased risk for sterile infiltrates?

(Note: There is some degree of overlap between the following questions and those from the previous section)
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- The use of a BCL, especially in conjunction with the use of topical NSAIDs without concurrent topical steroids.
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Post-surface ablation sterile infiltrates
Surface Ablation Issues I: Sterile Infiltrates

- **What post-surgical maneuver after surface ablation puts the pt at increased risk for sterile infiltrates?**
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- **What are the keys to management of sterile infiltrates?**
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- Add topical steroids and taper topical NSAIDs
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Post-surface-ablation haze can be divided into two categories based on time of onset—what are they?

- ?
- ?
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- Early onset
- Late onset
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For each, how long after surgery until it appears?
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- Early onset. A couple of weeks.
- Late onset. Six to twelve months.

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What are the risk factors for development of severe haze?

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- Small vs large ablation zone
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How is haze treated?

- Increase steroid use. If this fails…
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How is haze treated?
- Increase steroid use. If this fails…
- Debridement in conjunction with topical MMC
Figure 1. Slit-lamp microscopy of a cornea before scraping and mitomycin C treatment. The central scar is dense and leads to an irregular and whitish surface.

Figure 2. The same cornea as Figure 1 after scraping and mitomycin C treatment. Six months after the procedure the corneal tissue is clear and no trace of haze is evident.

Post-surface ablation corneal haze: Pre- and post tx
Cutting the flap with a microkeratome…problems

- Adequate suction induces an IOP of at least \# \text{mmHg}.
LASIK Issues I: Cutting The Flap

- Cutting the flap with a microkeratome…problems
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**LASIK Issues I: Cutting The Flap**

- Cutting the flap with a microkeratome...problems
  - Adequate suction induces an IOP of at least **65** mmHg
  - Inadequate suction ↑ the risk of a flap prob 1 or flap prob 2
LASIK Issues I: Cutting The Flap

- **Cutting the flap with a microkeratome...problems**
  - Adequate suction induces an IOP of at least $65$ mmHg
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LASIK flap: Buttonhole
Cutting the flap with a microkeratome…problems

- Adequate suction induces an IOP of at least 65 mmHg
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- A steep (>46D) cornea ↑ the risk of a thin flap or buttonhole as well
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LASIK Issues I: Cutting The Flap

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  - Inadequate suction ↑ the risk of a thin flap or buttonhole
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LASIK flap: Free cap
LASIK Issues I: Cutting The Flap

Cutting the flap with a microkeratome…problems

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- Inadequate suction ↑ the risk of a **thin flap** or **buttonhole**
- A steep (>46D) cornea ↑ the risk of a **thin flap** or **buttonhole** as well
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How do you manage a…

- Thin flap/buttonhole?
LASIK Issues I: Cutting The Flap

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  - Thin flap/buttonhole? Stop the procedure; re-cut in 3-6 months
  - Free cap? Place in antidessication chamber; finish the procedure; re-place the cap +/- sutures
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

?  ?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Microstriae
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Microstriae

[Images of eye with striae]
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Microstriae

What are the two main risk factors for striae?

--?

--?
Flap Striae

Two broad category of striae

Macrostriae

Microstriae

What are the two main risk factors for striae?
- Thin vs thick flaps
- Deep vs shallow ablations
Flap Striae

Two broad category of striae

Macrostriae

Microstriae

*What are the two main risk factors for striae?*

--Thin flaps

--Deep ablations
Flap Striae

Two broad category of striae

- Macrostriae
- Microstriae

Do all striae require treatment?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Microstriae

Do all striae require treatment?
No. If BCVA and subjective VA are good, folds can be observed
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Microstriae

Extent of flap involved
**LASIK Issues II: Flap Striae and Dislocation**

Flap Striae

- Macrostriae: Full flap  
  - **Extent of flap involved**
- Microstriae: Bowman’s layer only

*Two broad category of striae*
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Extent of flap involved
- Clinically significant?

Microstriae
- Bowman’s layer only
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always

Microstriae
- Extent of flap involved
  - Bowman’s layer only
- Clinically significant?
  - Rarely
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
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Extent of flap involved
Clinically significant?
Cause

Microstriae
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LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Full flap
Always
Flap slippage

Extent of flap involved
Clinically significant?
Cause

Microstriae

Bowman’s layer only
Rarely
Flap contracture
**LASIK Issues II: Flap Striae and Dislocation**

**Flap Striae**

Two broad category of striae

- **Macrostriae**
  - Full flap
  - Always
  - Flap slippage

- **Microstriae**
  - Bowman’s layer only
  - Rarely

**Extent of flap involved**

**Clinically significant?**

**Cause**

**Flap contracture**

---

What is probably the most common cause of flap slippage leading to macrostriae?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture

Extent of flap involved
Clinically significant?
Cause

What is probably the most common cause of flap slippage leading to macrostriae?
Eyelid squeezing by the pt upon removal of the speculum
A pt has multiple macrostriae, all oriented parallel to one another. They stem from the hinge. What is the likely cause?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

Full flap
Always
Flap slippage

Extent of flap involved
Clinically significant?

Cause

Microstriae

Bowman’s layer only
Rarely
Flap contracture

A pt has multiple macrostriae, all oriented parallel to one another. They stem from the hinge. What is the likely cause? Frank slippage of the flap. Re-place it immediately!
LASIK flap: Folds from flap slippage
A pt has multiple macrostriae, all oriented parallel to one another. They stem from the hinge. What is the likely cause? Frank slippage of the flap. Re-place it immediately!

Why must slippage be addressed immediately?

Two broad category of striae

Flap Striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Cause
- Extent of flap involved
- Clinically significant?

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
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How quickly?
A pt has multiple macrostriae, all oriented parallel to one another. They stem from the hinge. What is the likely cause? Frank slippage of the flap. Re-place it immediately!

Why must slippage be addressed immediately?
Because if left in place, folds quickly become permanent

How quickly?
Within roughly 24 hours
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

- Full flap
- Always
- Flap slippage

Microstriae

- Bowman’s layer only
- Rarely
- Flap contracture

Two arrows indicate:

- Extent of flap involved
- Clinically significant?
- Cause
- Gutter status
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected

\[ \text{Extent of flap involved} \]
\[ \text{Clinically significant?} \]
\[ \text{Cause} \]
\[ \text{Gutter status} \]
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

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- Always
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- Widened

Extent of flap involved
Clinically significant?
Cause
Gutter status

Microstriae

- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected

Why do macrostriae tend to widen the flap gutter?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

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- Always
- Flap slippage
- Widened

Extent of flap involved
Clinically significant?
Cause
Gutter status

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected

Why do macrostriae tend to widen the flap gutter? Because the folds reduce the surface area the flap can cover
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae

- Full flap
- Always
- Flap slippage
- Widened

Microstriae

- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected

**Extent of flap involved**

**Clinically significant?**

**Cause**

**Gutter status**

**Acute treatment**
**LASIK Issues II: Flap Striae and Dislocation**

**Flap Striae**

Two broad category of striae

---

**Macrostriae**

- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace

**Microstriae**

- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication

---

*Extant of flap involved*  
*Clinically significant?*  
*Cause*  
*Gutter status*  
*Acute treatment*
LASIK Issues II: Flap Striae and Dislocation

**Flap Striae**

- **Macrostromiae**
  - Full flap
  - Always
  - Flap slippage
  - Widened
  - Lift and replace

- **Microstromiae**

  **Extent of flap involved**
  - Always
  - Clinically significant?
  - Cause
  - Gutter status
  - Acute treatment

  **Classic description**

  **Two broad category of striae**

  **Bowman’s layer only**
  - Rarely
  - Flap contracture
  - Unaffected
  - Observation; lubrication
Flap Striae

Two broad categories of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace
- ‘Skewed carpet’

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’

Extent of flap involved
Clinically significant?
Cause
Gutter status
Acute treatment
Classic description
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
Full flap
Always
Flap slippage
Widened
Lift and replace
‘Skewed carpet’

Microstriae
Bowman’s layer only
Rarely
Flap contracture
Unaffected
Observation; lubrication

What clinical maneuver helps bring out the cracked mud appearance?

Instillation of fluorescein. The microstriae will be visualized as areas of negative staining.
### LASIK Issues II: Flap Striae and Dislocation

#### Flap Striae

<table>
<thead>
<tr>
<th>Macrostriae</th>
<th>Microstriae</th>
</tr>
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<tbody>
<tr>
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<td>‘Cracked mud’</td>
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</table>

#### Two broad category of striae

- **Microstriae**: Full flap Bowman’s layer only
- **Macrostriae**: Always Rarely

**Extent of flap involved**

**Clinically significant?**

**Cause**

**Gutter status**

**Acute treatment**

**Classic description**

---

What clinical maneuver helps bring out the cracked mud appearance? **Instillation of fluorescein.** The microstriae will be visualized as areas of positive vs negative staining.
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace
- ‘Skewed carpet’

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’

Extent of flap involved
Clinically significant?
Cause
Gutter status
Acute treatment
Classic description

What clinical maneuver helps bring out the cracked mud appearance?
Instillation of fluorescein. The microstriae will be visualized as areas of negative staining.
Microstriae: ‘Cracked mud’ appearance after fluorescein instillation
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace
- ‘Skewed carpet’

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’

- Extent of flap involved
- Clinically significant?
- Cause
- Gutter status
- Acute treatment
- Classic description
- Visible w/ direct illumination
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace
- ‘Skewed carpet’
- Yes
  - Extent of flap involved
  - Clinically significant?
  - Cause
  - Gutter status
  - Acute treatment
  - Classic description
  - Visible w/ direct illumination

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’
- No
A pt is found to have **circumferential** striae. What was likely her pre-op refractive status?
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

- Macrostriae
  - Full flap
  - Always
  - Flap slippage
  - Widened
  - Lift and replace
  - ‘Skew carpet’
  - Yes

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- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’
- No

A pt is found to have **circumferential** striae. What was likely her pre-op refractive status?

High myopia
LASIK Issues II: Flap Striae and Dislocation

Flap Striae

Two broad category of striae

Macrostriae
- Full flap
- Always
- Flap slippage
- Widened
- Lift and replace
- ‘Skewed carpet’
- Yes

Microstriae
- Bowman’s layer only
- Rarely
- Flap contracture
- Unaffected
- Observation; lubrication
- ‘Cracked mud’
- No

Extent of flap involved
Clinically significant?
Cause
Gutter status
Acute treatment
Classic description
Visible w/ direct illumination

A pt is found to have circumferential striae. What was likely her pre-op refractive status?
High myopia

Are circumferential striae more or less concerning than other types of striae?
A pt is found to have circumferential striae. What was likely her pre-op refractive status?
High myopia

Are circumferential striae more or less concerning than other types of striae?
Less. They usually resolve spontaneously.
Flap dislocation

*Early*

- Often occurs on post-op day
Flap dislocation

- *Early*
  - Often occurs on post-op day 1
Flap dislocation

- *Early*

  - Often occurs on post-op day 1
  
    - In immediate post-op period, adhesion between flap epithelium and tarsal conjunctiva can be stronger than tensile strength of epithelial bridge across flap gutter.
LASIK Issues II: Flap Striae and Dislocation

- Flap dislocation
  - *Early*
    - Often occurs on post-op day 1
      - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter.
LASIK flap: Early post-op dislocation
Flap dislocation

**Early**
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

**Late**
- Usually secondary to

*LASIK Issues II: Flap Striae and Dislocation*
Flap dislocation

**Early**
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

**Late**
- Usually secondary to blunt trauma
Flap dislocation

Early
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

Late
- Usually secondary to blunt trauma
  - Some healing/scarring occurs at the location, but essentially none at the rest of the location
Flap dislocation

**Early**
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

**Late**
- Usually secondary to blunt trauma
  - Some healing/scarring occurs at the edge of the flap, but essentially none at the rest of the flap/stroma interface

LASIK Issues II: Flap Striae and Dislocation
Flap dislocation

*Early*
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

*Late*
- Usually secondary to blunt trauma
  - Some healing/scarring occurs at the edge of the flap, but essentially none at the rest of the flap/stroma interface
  - Lack of extensive healing means flap is always vulnerable to dislocation from blunt force
Flap dislocation

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Flap dislocation

- **Early**
  - Often occurs on post-op day 1
    - In immediate post-op period, adhesion between flap epithelium and *tarsal conj* can be stronger than tensile strength of epithelial bridge across flap gutter

- **Late**
  - Usually secondary to *blunt trauma*
    - Some healing/scarring occurs at the edge of the flap, but essentially none at the rest of the flap/stroma interface
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**Treatment:** Re-place flap ASAP!
Flap dislocation

Early
- Often occurs on post-op day 1
  - In immediate post-op period, adhesion between flap epithelium and tarsal conj can be stronger than tensile strength of epithelial bridge across flap gutter

Late
- Usually secondary to blunt trauma
  - Some healing/scarring occurs at the edge of the flap, but essentially none at the rest of the flap/stroma interface
  - Lack of extensive healing means flap is always vulnerable to dislocation from blunt force

Treatment: Re-place flap ASAP!
LASIK flap: Late, traumatic dislocation
LASIK Issues III: DLK

- DLK…
  - …stands for
LASIK Issues III: DLK

- DLK…
  - …stands for *diffuse lamellar keratitis*
DLK…

…stands for **diffuse lamellar keratitis**

aka **funny nickname** for its grainy appearance
● DLK…
  ● …stands for *diffuse lamellar keratitis*
    ● aka *Sands of Sahara* for its grainy appearance
Q

LASIK Issues III: DLK

- DLK…
  - …stands for **diffuse lamellar keratitis**
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  - …is a **noninfectious inflammation** of the flap-bed interface
DLK…

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LASIK Issues III: DLK

- DLK…
  - …stands for **diffuse lamellar keratitis**
  - aka **Sands of Sahara** for its grainy appearance
  - …is a **noninfectious** inflammation of the **flap-bed** interface
  - …is probably 2° to **very general process** of the **important LASIK location**
DLK…
- …stands for *diffuse lamellar keratitis*
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LASIK Issues III: DLK

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  - …is a *noninfectious* inflammation of the *flap-bed* interface.
  - …is probably 2° to *contamination* of the *interface* (with *RBCs*, *bacterial products*, etc)

1... 2... 3 possible culprits
DLK…
- stands for diffuse lamellar keratitis
- aka Sands of Sahara for its grainy appearance
- is a noninfectious inflammation of the flap-bed interface
- is probably 2° to contamination of the interface (with rust, RBCs, bacterial products, etc)
LASIK Issues III: DLK

- DLK...
  - ...stands for **diffuse lamellar keratitis**
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  - ...is a **noninfectious inflammation** of the flap-bed interface
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*In a nutshell:* DLK represents the accumulation of in the potential sub-flap space secondary to inflammation that develops in response to the presence in the interface of a mechanical or toxic insult
LASIK Issues III: DLK

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*In a nutshell:* DLK represents the accumulation of WBCs in the potential sub-flap space secondary to anterior stromal inflammation that develops in response to the presence in the interface of a mechanical or toxic insult
DLK…

...stands for **diffuse lamellar keratitis**

- aka **Sands of Sahara** for its grainy appearance

...is a **noninfectious** inflammation of the **flap-bed** interface

...is probably 2º to **contamination** of the **interface** (with **rust**, **RBCs**, **bacterial products**, etc)

...has 4 grades:
DLK…
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- ...is a [noninfectious inflammatory](https://en.wikipedia.org/wiki/Diffuse_lamellar_keratitis) of the flap-bed interface
- ...is probably 2° to [contamination](https://en.wikipedia.org/wiki/Diffuse_lamellar_keratitis) of the interface (with rust, RBCs, bacterial products, etc)
- ...has 4 grades:

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**LASIK Issues III: DLK**
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Diffuse lamellar keratitis (DLK). A, Grade 2 DLK. Note accumulation of inflammatory cells in the fine ridges created by the oscillating microkeratome blade.
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A, Grade 2 DLK. Note accumulation of inflammatory cells in the fine ridges created by the oscillating microkeratome blade.  

B, Stage 3 DLK showing dense accumulation of inflammatory cells centrally.
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Diffuse lamellar keratitis (DLK). A, Grade 2 DLK. Note accumulation of inflammatory cells in the fine ridges created by the oscillating microkeratome blade. B, Grade 3 DLK showing dense accumulation of inflammatory cells centrally. C, Grade 4 DLK with central scar and folds.
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Because you really don’t want DLK to progress to Grade 4…
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Because you **really** don’t want DLK to progress to Grade 4… The *Refractive Surgery* book recommends that ‘the surgeon should have a low threshold for irrigating under the flap in suspected cases of severe DLK’
LASIK Issues III: DLK

Stage 3

Stage 4

More DLK pics
**DLK vs Infectious Keratitis after LASIK**

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**Q**

**DLK**

**Infectious Keratitis**

**Time of onset (post-op)**

- Usually <24 hrs, no more than 3 days
- At least 2-3 days

**Location**

- ?
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### DLK vs Infectious Keratitis after LASIK

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*LASIK Issues III: DLK*
DLK is differentiated from infectious keratitis by the confinement of the infiltrate to the interface alone in DLK.
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_A: LASIK Issues III: DLK_
### LASIK Issues III: DLK

#### DLK vs Infectious Keratitis after LASIK

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*Your LASIK pt looks great—until two weeks or so post-op, when she develops what appears to be DLK. Should you crank up the steroids?*
Q/A

LASIK Issues III: DLK

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Your LASIK pt looks great—until two weeks or so post-op, when she develops what appears to be DLK. Should you crank up the steroids? Not until you rule out pressure-induced stromal keratopathy (PISK). Briefly, what is PISK? An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP. Is PISK common, or rare? Rare. What is the tx? Rapid steroid taper + glaucoma meds as needed to control IOP.
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## LASIK Issues III: DLK

### DLK vs Infectious Keratitis after LASIK

- **Time of onset (post-op)**: 10-14 days vs At least 2-3 days
- **Location**: Peripheral (initially) vs Can be anywhere
- **Depth of involvement**: Limited to interface vs Extends into flap and/or underlying stroma
- **Photosensitivity?**: Yes vs Yes
- **Conj injection?**: Yes vs Yes
- **AC reaction?**: Rare vs Common

### PISK

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**What is PISK?**

An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP.

Is PISK common, or rare? Rare

What is the tx? Rapid steroid taper + glaucoma meds as needed to control IOP.
## DLK vs Infectious Keratitis after LASIK

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**What is PISK?**
An accumulation in the flap-stroma interface of transudated across the endothelium by a two words elevation in IOP.
DLK vs Infectious Keratitis after LASIK

Your LASIK pt looks great—until two weeks or so post-op, when she develops what appears to be DLK. Should you crank up the steroids? Not until you rule out pressure-induced stromal keratopathy (PISK).

What is PISK?
An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP.
PISK. Note the presence of an optically clear, fluid-filled space between the flap and stromal bed.
Your LASIK pt looks great—until two weeks or so post-op, when she develops what appears to be DLK. Should you crank up the steroids?

**This is why PISK doesn’t appear before 10 days at the earliest—it takes that long (or longer) for IOP to rise in response to steroids.**

What is PISK?
An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a **steroid-induced** elevation in IOP.

### DLK vs Infectious Keratitis after LASIK

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An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a **steroid-induced** elevation in IOP.
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What is PISK?
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Is PISK common, or rare?
LASIK Issues III: DLK

DLK vs pressure-induced stromal keratopathy after LASIK

PISK

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**LASIK Issues III: DLK**

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**What is the tx?**

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### LASIK Issues III: DLK

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### LASIK Issues III: DLK

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**PISK**

- **Time of onset (post-op)**: 10-14 days<br>**Location**: Peripheral (initially)<br>**Depth of involvement**: Limited to interface<br>**Photosensitivity**: Yes<br>**Conj injection**: Yes<br>**AC reaction**: Rare<br>**Can PISK result in severe vision loss? What is the mechanism of vision loss?**<br>**Her IOP is normal. Is it safe to assume this is just (very) late-onset DLK?**

- **What is the tx?**
  - Rapid steroid taper + glaucoma meds as needed to control IOP
LASIK Issues III: DLK

- DLK vs Infectious Keratitis after LASIK

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An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP.

Is PISK common, or rare?

Rare.

What is the tx?

Rapid steroid taper + glaucoma meds as needed to control IOP.

Her IOP is normal. Is it safe to assume this is just (very) late-onset DLK?

Not necessarily—it depends on how IOP was measured.

It was checked via the gold standard of IOP measurement—Goldmann applanation. **Now** can I assume it’s late-onset DLK?

Is it common, or rare?

Rare.

What is the tx?

Rapid steroid taper + glaucoma meds as needed to control IOP.

Indeed it can. Straight up uncontrolled, severe glaucoma.
**LASIK Issues III: DLK**

**DLK vs pressure-induced stromal keratopathy after LASIK**

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Now can I assume it’s late-onset DLK?

Mos def not. The presence of a layer of fluid beneath the flap renders applanation tonometry readings falsely low.

Can PISK result in severe vision loss? What is the mechanism of vision loss?

Indeed it can. Straight up uncontrolled, severe glaucoma.
LASIK Issues III: DLK

DLK vs Infectious Keratitis after LASIK

- DLK is pressure-induced stromal keratopathy.
- Infectious Keratitis is at least 2-3 days post-op.

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What is PISK?

- An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP

Is PISK common, or rare?

- Rare

What is the tx?

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**DLK vs Infectious Keratitis after LASIK**

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<tbody>
<tr>
<td><strong>Time of onset</strong></td>
<td>10-14 days ★</td>
<td>At least 2-3 days</td>
</tr>
</tbody>
</table>

Your LASIK pt looks great—until two weeks or so post-op, when she develops what appears to be DLK. Should you crank up the steroids?

Not until we rule out pressure-induced stromal keratopathy (PISK).

**What is PISK?**

An accumulation in the flap-stroma interface of aqueous transudated across the endothelium by a steroid-induced elevation in IOP.

**Is PISK common, or rare?**

Rare

**What is the tx?**

Rapid steroid taper + glaucoma meds as needed to control IOP.

Her IOP is normal. Is it safe to assume this is just (very) late-onset DLK?

Not necessarily—it depends on how IOP was measured.

It was checked via the gold standard of IOP measurement—Goldmann applanation. Now can I assume it’s late-onset DLK?

Mos def not. The presence of a layer of fluid beneath the flap renders applanation tonometry readings falsely low. When PISK is on the DDx, always check IOP with a Tono-Pen (or other device that doesn’t rely on applanation).

Can PISK result in severe vision loss? What is the mechanism of vision loss?

Indeed it can.

What is the tx?

Rapid steroid taper + glaucoma meds as needed to control IOP.
**LASIK Issues III: DLK**

**DLK vs Infectious Keratitis after LASIK**

**PISK**

<table>
<thead>
<tr>
<th>Time of onset (post-op)</th>
<th>DLK</th>
<th>Infectious Keratitis</th>
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Can PISK result in severe vision loss? *What is the mechanism of vision loss?*

Indeed it can. Straight up uncontrolled, severe glaucoma.
These patients should give you pause before proceeding with ablative keratorefractive surgery:
These patients should give you pause before proceeding with ablative keratorefractive surgery:

- The patient with a POcHx of HSV infection
These patients should give you pause before proceeding with ablative keratorefractive surgery:
- The patient with a PocHx of HSV keratitis
These patients should give you pause before proceeding with ablative keratorefractive surgery:

- The patient with a POcHx of **HSV keratitis**

What is the concern re operating on patients with a history of HSV keratitis?
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What is the concern re operating on patients with a history of HSV keratitis?
Re-activation of the virus
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- The patient with a POCHx of **HSV keratitis**
- The patient with a POCHx of **abb.**
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- The patient with PMHx of **two words**
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Generally speaking, to what undesirable post-op state does RA (and other connective-tissue conditions) contribute?
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Generally speaking, to what undesirable post-op state does RA (and other connective-tissue conditions) contribute?
That of poor/delayed wound healing
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What medical condition, vastly more common than RA, is also associated with poor wound healing?
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What dreaded post-op complication—an extreme manifestation of poor wound healing—can occur in post-photoablative RA patients?
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Wound melt
Photoablative Surgery: Other Issues

Post-LASIK corneal melt in an RA pt
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What medical condition, vastly more common than RA, is also associated with poor wound healing?

What ocular condition frequently co-exists with RA, such that the outcome of photoablative surgery may be suboptimal even in the absence of poor healing and/or a wound melt?

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Wound melt
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Generally speaking, to what undesirable post-op state does RA (and other connective-tissue conditions) contribute?
That of poor/delayed wound healing

Speaking of delayed corneal wound healing…Certain medications are notorious for inducing this, and thus their use is a relative contraindication to photoablative surgery. What are they?

- ?? (used to treat migraines and cluster HAs)
- ?? (used to treat acne)
- ?? (used to treat ventricular arrhythmias)
- ?? (used to treat symptoms of menopause, and/or osteoporosis prevention)
- ?? (OTC; used to treat allergic conditions)
Photoablative Surgery: Other Issues

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- Sumatriptan (used to treat migraines and cluster HAs)
- Isotretinoin (used to treat acne)
- Amiodarone (used to treat ventricular arrhythmias)
- HRT (used to treat symptoms of menopause, and/or osteoporosis prevention)
- Antihistamines (OTC; used to treat allergic conditions)
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- Amiodarone
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- Anti histamines

No question—proceed when ready

Note: It’s unclear how strong a contraindication to surgery these meds should be considered. One highly-placed Academy resource states they “are believed to cause delayed corneal wound healing, and caution should be used in pts who take them.”
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No question—proceed when ready
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In addition to delaying wound healing, isotretinoin contributes to suboptimal photoablative outcomes by exacerbating another condition known to negatively impact them—what condition?
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- The patient with PMHx of rheumatoid arthritis
- The patient whose pre-op exam suggests the possibility of forme fruste keratoconus or other ectatic disorder
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- The patient with a POcHx of **DES**
- The patient with PMHx of **rheumatoid arthritis**
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Of these four conditions, which one is probably most widely regarded as a contraindication to keratorefractive surgery?
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This assertion is technically incorrect. Keratoconus is certainly a contraindication for RK as well as keratoablative procedures such as LASIK and PRK. However, there is a keratorefractive procedure that is not only not contraindicated in keratoconus, it is used to treat keratoconus. What is it? Corneal inlay (ie, Intacs) procedure.

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Corneal inlay (ie, Intacs) procedure

For more on corneal inlays, see slide-set RS9

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BTW, even this is not universal—there are good and honorable surgeons who will perform keratoablative refractive surgery on select forme fruste patients

No question—proceed when ready
These patients should give you pause before proceeding with ablative keratorefractive surgery:

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- The patient with PMHx of **rheumatoid arthritis**
- The patient whose pre-op exam suggests the possibility of **forme fruste keratoconus** or other **ectatic** disorder
- The pt who is **general health status**
These patients should give you pause before proceeding with ablative keratorefractive surgery:

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- The patient whose pre-op exam suggests the possibility of **forme fruste keratoconus** or other **ectatic** disorder
- The pt who is **immunocompromised**
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When you hear ‘immunocompromised,’ two health scenarios should spring to mind—what are they?

--?

--?
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*When you hear ‘immunocompromised,’ two health scenarios should spring to mind—what are they?*

--HIV/AIDS
--Cancer
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*Why are immunocompromised pts relatively poor candidates for surgery?*
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When you hear ‘immunocompromised,’ two health scenarios should spring to mind—what are they?
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Why are immunocompromised pts relatively poor candidates for surgery? Because they are at increased risk of post-op infection
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- The pt who is immunocompromised
- The pt who is pregnant or breastfeeding
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- The patient with PMHx of rheumatoid arthritis
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- The pt who is immunocompromised
- The pt who is pregnant or breastfeeding

Why are these contraindications to refractive surgery? (Hint: It has nothing to do with any systemic meds given to relax the pt for surgery.)
These patients should give you pause before proceeding with ablative keratorefractive surgery:

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*Why are these contraindications to refractive surgery? (Hint: It has nothing to do with any systemic meds given to relax the pt for surgery.)* Both can affect the hydration and/or refractive state of the cornea.
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Why are these contraindications to refractive surgery? (Hint: It has nothing to do with any systemic meds given to relax the pt for surgery.) Both can affect the hydration and/or refractive state of the cornea

How long after pregnancy (or breastfeeding) should one wait before performing keratorefractive surgery?
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- The patient with PMHx of rheumatoid arthritis
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Why are these contraindications to refractive surgery? (Hint: It has nothing to do with any systemic meds given to relax the pt for surgery.) Both can affect the hydration and/or refractive state of the cornea.

How long after pregnancy (or breastfeeding) should one wait before performing keratorefractive surgery? Most surgeons wait at least 3 months.
In this context, what does ectasia refer to?
In this context, what does ectasia refer to? A noninflammatory, progressive disorder of corneal biomechanics which leads to thinning and warping.
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- Ectatic disorders include:
  - three words
  - one word
  - different three words
  - abb.
In this context, what does ectasia refer to? A noninflammatory, progressive disorder of corneal biomechanics which leads to thinning and warping.

- Ectatic disorders include pellucid marginal degeneration, keratoglobus, Terrien marginal degeneration, KCN.
KCN Keratoglobus

Pellucid marginal degeneration

Terrien marginal degeneration
In this context, what does ectasia refer to? A noninflammatory, progressive disorder of corneal biomechanics which leads to thinning and warping

- Ectatic disorders include pellucid marginal degeneration, keratoglobus, Terrien marginal degeneration, KCN

Is post-surgery ectasia more common after LASIK, or surface procedures?
In this context, what does ectasia refer to? A noninflammatory, progressive disorder of corneal biomechanics which leads to thinning and warping.

Ectatic disorders include pellucid marginal degeneration, keratoglobus, Terrien marginal degeneration, KCN.

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While there are many risk factors, two dwarf the others in importance. What are they?

- A too-thin residual stromal bed (RSB).
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What is the tx? RGPs; CXL +/- ICRS; PK.