Photoablative Refractive Surgery

Refractive Surgery

Intraocular
- Pseudophakic
  - Refractive lens exchange (RLE)
- Phakic IOL
  - Iris-fixated
  - Sulcus-fixated

Corneal
- Incisional
  - RK
  - AK
  - LRI
- Laser
  - ?
  - ?
  - ?
  - ?

Other
- CK
- SAI
- CRI
- CXL
- ICRS
Photoablative Refractive Surgery

Refractive Surgery

Intraocular

Pseudophakic
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Incisional
- RK
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Laser
- PRK
- LASEK
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- LASIK
- SMILE

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What does PRK stand for?
PhotoRefractive Keratectomy

What does LASEK stand for?
LASer SubEpithelial Keratomileusis

What does Epi-LASIK stand for?
Epipolis LASer In-situ Keratomileusis

What does LASIK stand for?
LASer In-situ Keratomileusis

What does SMILE stand for?
SMall-Incision Lenticule Extraction
One of these techniques is not like the others—one of these techniques just doesn’t belong. Which one?
Photoablative Refractive Surgery

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Why doesn’t SMILE belong in a slide-set concerning photoablative refractive procedures?
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Why doesn’t SMILE belong in a slide-set concerning photoablative refractive procedures? Photoablative procedures use laser energy to ablate (destroy) corneal tissue, whereas SMILE uses a laser to carve and isolate an intrastromal block (called a lenticule) of tissue, which is then removed en bloc. In other words, while SMILE results in a loss of corneal tissue, that tissue is not ablated. (More on SMILE later in the slide-set.)
What sort of laser is used to ablate the corneal tissue?

An excimer laser

What is the origin of the word excimer?

It is a contraction of the term excited di-mer.

What does excited dimer mean in this context?

The active medium in an excimer consists of a diatomic combination of two elemental gases.

Which gas combo is most commonly used in ophthalmic excimer lasers?

Argon-fluoride

What is the wavelength of light employed?

193 nm

Is 193 nm in the UV range, or the infrared range?

UV

Does light of this wavelength penetrate tissue?

Hardly at all, which makes it perfect for surface ablation.

Is this form of radiation mutagenic?

No

Is the laser energy delivered continuously, or in pulsatile fashion?

Pulsatile
What sort of laser is used to ablate the corneal tissue? An *excimer* laser.
**Photoablative Refractive Surgery**

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Other than beam size, how do flying-spot and broad-beam lasers differ?
- The amount of energy/pulse is far greater with the broad-beam laser
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Which beam subtype is most frequently employed in current clinical practice?
Flying spot

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What is the diameter of the:
--Flying-spot laser? 0.5 - 2 mm
--Broad-beam laser? 7 mm

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- **Which beam subtype is widely considered obsolete?**

- Which beam subtype is most frequently employed in current clinical practice?
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Which beam subtype is widely considered obsolete? Broad beam.

Which beam subtype is most frequently employed in current clinical practice? Flying spot.

Laser

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Other

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In this context, what is The Munnerlyn Formula?
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The Munnerlyn Formula:

Ablation depth = \( \frac{\text{Degree of Myopia in Diopters} \times (\text{the optical-zone diameter in mm})^2}{3} \)
Photoablative Refractive Surgery

In words, what does the Munnerlyn formula tell us?

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Photoablative Refractive Surgery

Refractive Surgery

Intraocular
- Pseudophakic
  - Refractive lens exchange (RLE)
- Phakic IOL
  - Iris-fixated
  - Sulcus-fixated

Corneal
- Incisional
  - RK
  - AK
  - LRI
- Laser
  - PRK
  - LASEK
  - Epi-LASIK
  - LASIK
- Other
  - CK
  - SAI
  - CRI
  - CXL
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Does the Munnerlyn formula apply to hyperopic photoablative refractive surgery?

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Refractive Surgery

Corneal

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PRK
LASEK
Epi-LASIK
LASIK

Other

CK
SAI
CRI
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Why is PRK so painful post-operatively?

Think about it—essentially, the surgeon is creating a large central epithelial defect, an excruciating condition that takes several days to resolve.

Why is haze formation so prevalent?

Haze formation seems to be an inflammatory reaction. Think of the epithelial cells as little water balloons with inflammatory cytokines floating within them. When the epithelium is handled roughly, the water balloons burst, showering the underlying surface with these cytokines, setting off an inflammatory cascade that ultimately results in haze formation. For this reason, keratorefractive surgeons have learned to handle the epithelium more gingerly and with much greater respect!

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What therapeutic maneuver to prophylax against haze formation after PRK has become commonplace? Treating the residual stromal bed with topical Mitomycin C (Abb).

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Photoablatable Refractive Surgery

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What is MMC?
Mitomycin C, a chemotherapeutic agent

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How does LASIK deal with the epithelium?

- LASIK deals with the epithelium by doing an end-run around it. A hinged flap is cut in the stroma and reflected, thereby moving the epithelium out of the treatment area. The underlying stromal bed is then lased, and the flap (with its intact epithelium) is laid back in place.
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Photoablative Refractive Surgery

**Refractive Surgery**

- Corneal
  - Haze formation
    - Surface Ablation
      - Incisional
        - RK
        - AK
        - LRI
      - Laser
        - PRK
        - LASEK
        - Epi-LASIK
        - LASIK
    - Flap-Based Procedure
      - Iris-fixated
      - Intraocular Pseudophakic Phakic IOL
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    - Other
      - CK
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- Recovery time
  - Slower
  - Faster

- Post-op infection risk
  - Same

- Post-op pain
  - Worse

- Scarring risk
  - Higher risk

- Ectasia risk
  - Lower

- Higher vs lower risk
  - Other
### Photoablative Refractive Surgery

**Refractive Surgery**

- **Corneal**
  - **Incisional**
  - **Laser**
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
  - **Iris-fixated**
    - RK
    - AK
    - LRI
  - **Sulcus-fixated**
    - RK
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    - LRI
  - **Refractive lens exchange (RLE)**

### Comparison Table

<table>
<thead>
<tr>
<th>Haze formation</th>
<th>Surface Ablation</th>
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<td></td>
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<td>Lower risk</td>
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### Risks and Outcomes

- **Haze formation**: Higher risk vs Lower risk
- **Post-op pain**: Worse vs Better
- **Recovery time**: Slower vs Faster
- **Ectasia risk**: Lower vs Higher
- **Post-op infection risk**: Same vs Same

### Other Procedures
- CK
- SAI
- CRI
- CXL
- ICRS
Photoablative Refractive Surgery

Refractive Surgery

Corneal

Surface Ablation

Flap-Based Procedure

Haze formation

Higher risk

Lower risk

Scarring

higher vs lower risk

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LRI

Laser

PRK

LASEK

Epi-LASIK

LASIK

Other

CK

SAI

CRI

CXL

ICRS
# Photoablative Refractive Surgery

## Refractive Surgery

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- Higher risk
- Lower risk

## Corneal

- Incisional
  - RK
  - AK
  - LRI
- Iris-fixated
- Intraocular
- Pseudophakic
- Phakic IOL

## Laser

- PRK
- LASEK
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## Other

- CK
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Photoablative Refractive Surgery

Refractive Surgery

Corneal

Laser
- PRK
- LASEK
- Epi-LASIK
- LASIK

Incisional
- RK
- AK
- LRI

Fixated

Surface Ablation
- Haze formation: Higher risk, Lower risk
- Scarring: Higher risk, Lower risk
- Post-op pain: worse vs better

Flap-Based Procedure
## Photoablative Refractive Surgery

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Other:
- CK
- SAI
- CRI
- CXL
- ICRS

### Comparison

- **Haze formation**
  - Surface Ablation: Higher risk
  - Flap-Based Procedure: Lower risk

- **Scarring**
  - Surface Ablation: Higher risk
  - Flap-Based Procedure: Lower risk

- **Post-op pain**
  - Surface Ablation: Worse
  - Flap-Based Procedure: Better

### Risks
- **Post-op infection risk**: Same

### Recovery
- **Post-op pain**: Worse → Better
- **Recovery time**: Slower → Faster
## Photoablative Refractive Surgery

### Refractive Surgery

#### Corneal

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#### Laser

- PRK
- LASEK
- Epi-LASIK
- LASIK

#### Other

- CK
- SAI
- CRI
- CXL
- ICRS

### Risk Comparison

#### Recovery time
- Slower vs faster
# Photoablative Refractive Surgery

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## Laser

- PRK
- LASEK
- Epi-LASIK
- LASIK

## Other

- CK
- SAI
- CRI
- CXL
- ICRS

## Risks

- Haze formation: Higher risk vs Lower risk
- Scarring: Higher risk vs Lower risk
- Post-op pain: Worse vs Better
- Recovery time: Slower vs Faster
- Ectasia risk: higher vs lower risk

## Procedures

- Incisional
- RK
- AK
- LRI

- Iris-fixated
- Sulcus-fixated

- Refractive lens exchange (RLE)

- Haze formation: Higher risk vs Lower risk
- Scarring: Higher risk vs Lower risk
- Post-op pain: Worse vs Better
- Recovery time: Slower vs Faster
- Ectasia risk: higher vs lower risk

- Refractive Surgery

- Corneal
# Photoablative Refractive Surgery

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- **Laser**
  - PRK
  - LASEK
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- **Incisional**
  - RK
  - AK
  - LRI
- **Iris-fixated**
  - **Post-op infection risk**
  - Same
- **Sulcus-fixated**
  - **Ectasia risk**
  - Higher
- **Other**
  - CK
  - SAI
  - CRI
  - CXL
  - ICRS

### Comparison
- **Haze formation**
  - Higher risk (Surface Ablation)
  - Lower risk (Flap-Based Procedure)

- **Scarring**
  - Higher risk (Surface Ablation)
  - Lower risk (Flap-Based Procedure)

- **Post-op pain**
  - Worse (Surface Ablation)
  - Better (Flap-Based Procedure)

- **Recovery time**
  - Slower (Surface Ablation)
  - Faster (Flap-Based Procedure)

- **Ectasia risk**
  - Lower (Surface Ablation)
  - Higher (Flap-Based Procedure)
Photoablative Refractive Surgery

Refractive Surgery

Corneal

Incisional

Laser

PRK
LASEK
Epi-LASIK
LASIK

Other

CK
SAI
CRI
CXL
ICRS

Surface Ablation

Flap-Based Procedure

Haze formation
Higher risk
Lower risk

Scarring
Higher risk
Lower risk

Post-op pain
Worse
Better

Recovery time
Slower
Faster

Ectasia risk
Lower
Higher

Post-op infection risk
higher vs lower risk
### Photoablatative Refractive Surgery

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#### Laser

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Photoablative Refractive Surgery

Refractive Surgery

Corneal

Laser

- PRK
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Incisional

- RK
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Fixated

Iris-fixated

Intraocular

Pseudophakic

Phakic IOL

Refractive lens exchange (RLE)

Flap-Based Procedure

Surface Ablation

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This assertion is a bit misleading, because while post-op infection rates are about the same, infections after surface ablation are actually easier to treat because:

1) and

2)
This assertion is a bit misleading, because while post-op infection rates are about the same, infections after surface ablation are actually easier to treat because:
1) they are on the surface and thus more directly vulnerable to antibiotic drops; and
2) the bug is usually a common Gram(+) variety, whereas sub-flap bugs are more likely to be unusual/atypical.
There are certain clinical scenarios in which surface ablation procedures are preferred over LASIK, or at least have certain advantages. For example:

--Pt age: If the pt is relatively young, surface ablation is preferred.
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- Certain corneal issues argue in favor of PRK rather than LASIK. What are they?
  - Anticipated thin residual stromal bed if LASIK is performed
  - Thin cornea
  - Unusually steep or flat corneas
  - EBMD
  - Unusual topography
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Does ‘relatively young’ mean less than 18 years of age?
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Does ‘relatively young’ mean less than 18 years of age?
No, because individuals younger than 18 should not undergo keratorefractive surgery (in fact, many surgeon will decline to operate on individuals younger than 21).
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Photoablative Refractive Surgery

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Refractive Surgery

Intraocular

Pseudophakic

Refractive lens exchange (RLE)

Iris-fixated

Sulcus-fixated

---

RK
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Why is a thin residual stromal bed (RSB) undesirable?

Because it increases the likelihood that the cornea could suffer post-surgical ectasia

What is the minimum RSB value most surgeons will accept?

250 \( \mu \text{m} \)
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Why is a thin cornea less-than-ideal for LASIK?
Because all else being equal, the chance of ending up with a thin RSB is greater.
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--Unusual topography

How steep is ‘too steep’?

How flat is ‘too flat’?

About 48D

About 40D

Why are too-steep and/or too-flat corneas not good candidates for LASIK?

Because the extreme corneal curvature increases the likelihood of a complication occurring during flap creation

If a pt with a too-steep or too-flat cornea insists on LASIK, what surgical adjustment can be made that will greatly reduce the likelihood of a flap complication?

Create the flap with a femtosecond laser rather than a mechanical keratome
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How steep is ‘too steep’?
About 48D

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About 40D

What complication is likely to occur if the cornea is:
--too steep?
--too flat?

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How steep is ‘too steep’?
About 48D

How flat is ‘too flat’?
About 40D

What complication is likely to occur if the cornea is:
--too steep? A too-thin flap, or a ‘buttonhole’ flap
--too flat? A free cap

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Because the extreme corneal curvature increases the likelihood of a complication occurring during flap creation
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--Anticipated thin residual stromal bed if LASIK is performed.
--Thin cornea.
--Unusually steep or flat corneas.
--EBMD.

How steep is 'too steep'? About 48D.

How flat is 'too flat'? About 40D.

What is a...buttonhole flap? A flap with a central perforation.

What is a free cap? A flap unattached to the K (ie, the hinge is cut).

Why are too-steep and/or too-flat corneas not good candidates for LASIK? Because the extreme corneal curvature increases the likelihood of a complication occurring during flap creation.
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How steep is ‘too steep’?

About 48D

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What is a…

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Certain corneal issues argue in favor of PRK rather than LASIK. What are they?

--Anticipated thin residual stromal bed if LASIK is performed
--Thin cornea
--Unusually steep or flat corneas
--EBMD
--Unusual topography

How steep is ‘too steep’?
About 48D

How flat is ‘too flat’?
About 40D

Why are too-steep and/or too-flat corneas not good candidates for LASIK?
Because the extreme corneal curvature increases the likelihood of a complication occurring during flap creation.

If a pt with a too-steep or too-flat cornea insists on LASIK, what surgical adjustment can be made that will greatly reduce the likelihood of a flap complication?
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If a pt with a too-steep or too-flat cornea insists on LASIK, what surgical adjustment can be made that will greatly reduce the likelihood of a flap complication?
Create the flap with a femtosecond laser rather than a mechanical keratome.
Photoablative Refractive Surgery

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In this context, what does EBMD stand for?

Epithelial basement membrane disease

What general class of disease is it?

A corneal dystrophy

What are three other common names for EBMD?

--Map-dot-fingerprint dystrophy
--Cogan's microcystic dystrophy
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Photoablative Refractive Surgery

Are there ocular conditions that are contraindications (to at least some degree) to photoablative refractive surgery?

Yes. These include:

-- Ectatic conditions
-- Fuch’s dystrophy
-- Stromal dystrophies
-- Pts with neurotrophic corneas
-- Dry-eye syndrome
-- Monocular pts
-- Pts with diabetic retinopathy
-- Thyroid eye disease
-- A history of herpes zoster ophthalmicus

Are there systemic conditions that are contraindications (again, to at least some degree) to photoablative refractive surgery?

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Other

- PRK
- LASEK
- Epi-LASIK
- LASIK
- CK
- SAI
- CRI
- CXL
- ICRS
Photoablatative Refractive Surgery

Refractive Surgery

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As mentioned previously, the femtosecond laser is used to carve and isolate a disc-shaped portion of the corneal stroma (the lenticule). The lenticule is then removed ‘whole’ via a small incision connecting the created intrastromal space and the corneal surface. This loss of tissue flattens the central cornea.
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For myopia +/- astigmatism, yes