What are the three incisional procedures covered in the Refractive Surgery book?
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Incisional Corneal Refractive Surgery

Refractive Surgery

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

Corneal
- Incisional
- Laser
  - PRK
  - LASEK
  - Epi-LASIK
  - LASIK
  - SMILE
- Other
  - CK
  - SAI
  - CRI
  - CXL
  - ICRS

What does RK stand for?
Incisional Corneal Refractive Surgery

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Other
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*What does RK stand for?*  
Radial Keratotomy
Incisional Corneal Refractive Surgery

Refractive Surgery

- Corneal
  - Laser
    - RK
    - AK?
    - LRI
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    - Pseudophakic
      - Refractive lens exchange (RLE)
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What does RK stand for? Radial Keratotomy
What does AK stand for?
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What does AK stand for? Arcuate Keratotomy
Incisional Corneal Refractive Surgery

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What does RK stand for? Radial Keratotomy
What does AK stand for? Arcuate Keratotomy
What does LRI stand for? Limbal Relaxing Incisions
What is the fundamental difference between RK vs AK/LRI (other than that RK is no longer performed)?

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Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

Pseudophakic Phakic IOL

Corneal

Incisional

Laser

Other

RK
AK LRI

PRK LASEK Epi-LASIK LASIK SMILE

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Figure 2: Incisions
Images A through E: Example of eye with 4, 8, 12, 16, and 20 incisions.

Radial keratotomy
Radial keratotomy: 78 incisions!
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Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

Pseudophakic

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RK

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What is the fundamental difference between RK vs AK/LRI (other than that RK is no longer performed)?

RK is (was) used to correct myopia, whereas AK/LRI are used to correct astigmatism.

This is why RK can’t be used to treat hyperopia. Recall that hyperopes need additional plus-power to offset their hyperopia. Thus, to correct hyperopia, keratorefractive surgery has to steepen the central cornea to create the needed additional plus-power. But incising the cornea (ie, RK) can only flatten the central cornea—it cannot steepen it. So no RK for hyperopes.

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Steepening of the peripheral cornea leads inevitably to an increase in which higher-order aberration?

This steepens the peripheral cornea.
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Steepening of the peripheral cornea leads inevitably to an increase in which higher-order aberration?
Spherical aberration

This steepens the peripheral cornea.
Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

- Pseudophakic
- Phakic IOL

Corneal

- Incisional
  - RK
- Laser
  - PRK
- Other
  - CK

**Incisional Corneal Refractive Surgery**

**Briefly, how is RK performed?**
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion). Typically, they are 85-90% of the corneal thickness.

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Quite deep—about 85-90% corneal thickness.

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Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately).

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The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

**The native, normal cornea is steeper centrally than it is peripherally. What is the term for this shape?**

**Oblate**
**Incisional Corneal Refractive Surgery**

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The native, normal cornea is steeper centrally than it is peripherally.

How much steeper (in diopters) is the typical central cornea than the typical peripheral cornea?
3-4
Incisional Corneal Refractive Surgery

**Refractive Surgery**

- **Intraocular**
  - Pseudophakic
  - Phakic IOL

- **Corneal**
  - Incisional
  - Laser
  - Other

**Incisional Corneal Refractive Surgery**

- PRK
- LASEK
- CK
- ICRS
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**Prolate**

After RK (and other myopic keratorefractive procedures), this relationship is often reversed; ie, the central cornea is flatter than the peripheral cornea. What is the term for this shape?

**Oblate**
Refractive Surgery

Intraocular

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In two words, what is the main short-term problem with RK?
Refractive Surgery

Intraocular

Pseudophakic

Phakic IOL

Corneal

Incisional

Laser

Other

Refractive lens

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In two words, what is the main short-term problem with RK? ‘Diurnal fluctuation’

What does this refer to?
To the fact that a significant proportion of RK eyes are more hyperopic upon awakening in the morning.

Is this hyperopic shift permanent?
No. As the day proceeds, the extra hyperopia 'wears off,' and the eye reverts to its previous state.

What accounts for diurnal fluctuation?
Hypoxic edema. Closed eyelids during sleep deprive the cornea of O2, and the resulting hypoxia causes the incisions to swell a little. This swelling in turn induces increased flattening of the central cornea, resulting in more hyperopia. After several hours of O2 exposure while the eyes are open, the edema dissipates, and the excess hyperopia resolves.
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Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

Iris-fixated Intraocular Pseudophakic Phakic IOL

Corneal

Incisional Laser Other

Refractive lens

Incisional RK

PRK

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**Incisional Corneal Refractive Surgery**

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In two words, what is the main long-term problem with RK?
‘Hyperopic drift’

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Just over 40!
**Incisional Corneal Refractive Surgery**

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The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

In two words, what is the main long-term problem with RK?
'Hyperopic drift'

(Note: ‘Hyperopic drift’ is aka progressive flattening effect of surgery)
Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness.

How many cuts are made?
Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately).

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The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

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In two words, what is the main long-term problem with RK?
‘Hyperopic drift’

What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.
Incisional Corneal Refractive Surgery

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In two words, what is the main long-term problem with RK?
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What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Just over 40!
Incisional Corneal Refractive Surgery

**Refractive Surgery**

- **Intraocular**
  - Pseudophakic
  - Phakic IOL

- **Corneal**
  - Incisional
    - RK
  - Laser
    - PRK
  - Other
    - CK

**Briefly, how is RK performed?**
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion bounded by a 3-4 mm diameter ring).

**In two words, what is the main long-term problem with RK?**
‘Hyperopic drift’

**What does this refer to?**
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

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Over 40!

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Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

- Pseudophakic
- Phakic IOL

Corneal

- Incisional
- Laser
- Other

Incisional Corneal Refractive Surgery

PRK
LASEK
CK
ICRS
CXL
LASIK
SMILE
Epi-LASIK
RK
AK
LRI

Briefly, how is RK performed?
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The fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

For those pts with visually significant hyperopic drift, are they candidates for corrective keratorefractive surgery?
Yes, they can be treated with a keratoablative laser procedure (e.g., LASIK; PRK).

Which is preferable in a post-RK eye: a flap-based procedure (e.g., LASIK), or a surface-based procedure (e.g., PRK)?
While either is acceptable, surface-based procedures are probably preferable, as trying to create a flap in a post-RK cornea can lead to incision-related complications.
Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring). 

To two words, what is the main long-term problem with RK? 
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Incisional Corneal Refractive Surgery

Refractive Surgery

Intraocular

Pseudophakic

Phakic IOL

Corneal

Incisional

RK

Laser

PRK

Other

CK

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

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Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

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While either is acceptable, surface-based procedures are probably preferable, as trying to create a flap in a post-RK cornea can lead to incision-related complications.
Incisional Corneal Refractive Surgery

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea). The incisions result in corneal scarring, which changes corneal curvature.

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness.

How many cuts are made?
Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately).

How do radial cuts correct myopia?
The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

In two words, what is the main long-term problem with RK?
'Hyperopic drift'

What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!
In two words, what is the main long-term problem with RK?

Hyperopic drift

What does this refer to?

To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?

Over 40!

Briefly, how is RK performed?

Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

In two words, what is the main long-term problem with RK?

Hyperopic drift

What does this refer to?

To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?

Over 40!

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Incisional Corneal Refractive Surgery

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of cornea surrounded by 3-4 mm diameter ring). These incisions affect about 85-90% of corneal thickness.

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness.

How many cuts are made?
Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately)

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What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery

Why does RK lead to imprecise IOL calcs?
This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas. The trouble is, these assumptions were developed with virgin corneas. By inducing central corneal flattening, RK radically alters the relationship between central power and power at the 3-4 mm optical zone; thus, the assumptions simply no longer apply.

If standard IOL calc techniques are applied to an RK eye, will the resulting ‘refractive surprise’ be myopic, or hyperopic?
Hyperopic

In two words, what is the main long-term problem with RK?
Hyperopic drift

What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!
Incisional Corneal Refractive Surgery

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In two words, what is the main long-term problem with RK?
Hypermotic drift

What does this refer to?
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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40! ^

Why is RK lead to imprecise IOL calc?
This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas.

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness.

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The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.
Incisional Corneal Refractive Surgery

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring). These incisions are made at various places on a radial grid. The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery

Why does RK lead to imprecise IOL calcs?
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In two words, what is the main long-term problem with RK?
‘Hyperopic drift’

What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!
Incisional Corneal Refractive Surgery

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Imprecision in IOL calculations for cataract surgery

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If standard IOL calc techniques are applied to an RK eye, will the resulting ‘refractive surprise’ be myopic, or hyperopic?

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

In two words, what is the main long-term problem with RK?
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What does this refer to?
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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

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Incisional Corneal Refractive Surgery

Refractive Surgery

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery

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If standard IOL calc techniques are applied to an RK eye, will the resulting ‘refractive surprise’ be myopic, or hyperopic? Hyperopic

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring) quite deep—about 85-90% corneal thickness. Usually 4 or 8, occasionally 16, hopefully not 32 (although it's been done, unfortunately)

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness

How many cuts are made?
Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately)

How do radial cuts correct myopia?
The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

In two words, what is the main long-term problem with RK?
Hyperopic drift

What does this refer to?
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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

^other

other
Incisional Corneal Refractive Surgery

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)

Imprecision in IOL calculations for cataract surgery

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This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas. The trouble is, these assumptions were developed with virgin corneas. By inducing central corneal flattening, RK radically alters the relationship between central power and power at the optical zone.

If standard IOL calcs are applied to an RK eye, will the resulting ‘refractive surprise’ be myopic, or hyperopic?
Hyperopic

In two words, what is the main long-term problem with RK?
‘Hyperopic drift’

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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

Is there anything that can be done to reduce the likelihood of a hyperopic refractive surprise?
Yes. A number of alternative IOL power calculation techniques have been developed (see the IOL Calculations slide-set for details). The short version is as follows:

1. Determine corneal power by either:
   a. Measuring it directly (via a technology capable of doing so in a post-RK eye);
   b. Using keratometric measurements obtained pre-RK (usually difficult or impossible to obtain);
   c. Performing a hard contact-lens overrefraction;
2. Performing the calcs via several of the 3rd or 4th generation calc formula, then using the highest IOL power that pops out of those calcs.

Briefly, how is RK performed?
Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

How deep are these cuts made?
Quite deep—about 85-90% corneal thickness

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Incisional Corneal Refractive Surgery

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.) Imprecision in IOL calculations for cataract surgery

Why does RK lead to imprecise IOL calcs? This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas. The trouble is, these assumptions were developed with virgin corneas. By inducing central corneal flattening, RK radically alters the relationship between central power and power at the optical zone.

Is there anything that can be done to reduce the likelihood of a hyperopic refractive surprise? Yes. A number of alternative IOL power calculation techniques have been developed (see the IOL Calculations slide-set for details).

In two words, what is the main long-term problem with RK? Hyperopic drift

What does this refer to? To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time.

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years? Over 40!

Briefly, how is RK performed? Radial incisions are made that extend from the peripheral cornea to the edge of the ‘optical zone’ (central portion of the cornea bounded by a 3-4 mm diameter ring).

How deep are these cuts made? About 85-90% corneal thickness.

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Incisional Corneal Refractive Surgery

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)

Imprecision in IOL calculations for cataract surgery

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First, determine corneal power by either 1) measuring it directly (via a technology capable of doing so in a post-RK eye); 2) using keratometric measurements obtained pre-RK (usually difficult or impossible to obtain); or 3) performing a hard contact-lens overrefraction.

What does this refer to?
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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

Is there another problem associated with RK? (Hint: It’s usually not seen until pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery.

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According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!
Incisional Corneal Refractive Surgery

Refractive

What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery

Why does RK lead to imprecise IOL calcs?
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Second, performing the calcs via several of the 3rd or 4th generation calc formula, then using the highest IOL power that pops out of those calcs

What is the other main problem associated with RK?
Imprecision in IOL calculations for cataract surgery

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What does this refer to?
To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?
Over 40!

In two words, what is the main long-term problem with RK?
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What is the other main problem associated with RK? (Hint: It’s not usually encountered until the pt is 60+ years old.)
Imprecision in IOL calculations for cataract surgery.

Why does RK lead to imprecise IOL calcs?
This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas. The trouble is, these assumptions were developed with virgin corneas. By inducing central corneal flattening, RK radically alters the relationship between central power and power at the 3-4 mm optical zone.

Is there anything that can be done to reduce the likelihood of a hyperopic refractive surprise? Yes. A number of alternative IOL power calculation techniques have been developed (see the IOL Calculations slide-set for details). The short version is as follows:

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**Refractive Surgery**

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What about the cataract surgery itself—are there any adjustments in technique that should be considered?
Yes. The surgeon should give consideration to employing a two-words incision, in order to avoid ‘crossing’ the RK incisions.

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Yes. The surgeon should give consideration to employing a scleral-tunnel incision, in order to avoid ‘crossing’ the RK incisions.

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Incisional Corneal Refractive Surgery

Refractive Laser Surgery

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Yes. The surgeon should give consideration to employing a scleral-tunnel incision, in order to avoid ‘crossing’ the RK incisions.

If the RK cornea possesses significant astigmatism, where should the cataract incision be placed?
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Incisional Corneal Refractive Surgery

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Briefly, in two words, what is the main short-term problem with RK?

‘Diurnal fluctuation’

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What accounts for diurnal fluctuation?

Hypoxic edema. Closed eyelids during sleep deprive the cornea of O2, and the resulting hypoxia causes the incisions to swell a little. This swelling in turn induces increased flattening of the central cornea, resulting in more hyperopia. After several hours of increased O2 exposure while the eyes are open, the edema dissipates, and the excess hyperopia resolves.

Because of these (and other) issues, RK is considered ‘obsolete,’ and thus is no longer performed in the US

Why does RK lead to imprecise IOL calcs? This is discussed in greater depth in the slide-set entitled IOL Calculations. But briefly, the problem lies in the way central corneal power is determined. Standard techniques (keratometry; Placido-disc topography) don’t measure central power directly; rather, they measure power at about the 3-4 mm optical zone, then infer central power based on assumptions concerning the relationship between corneal curvature at these two areas. The trouble is, these assumptions were developed with virgin corneas. By inducing central corneal flattening, RK radically alters the relationship between central power and power at the 3-4 mm optical zone; thus, the assumptions simply no longer apply.

If standard IOL calc techniques are applied to an RK eye, will the resulting ‘refractive surprise’ be myopic, or hyperopic? Hyperopic

In two words, what is the main short-term problem with RK?

‘Diurnal fluctuation’

How deep are these cuts made?

Quite deep—about 85-90% corneal thickness

How many cuts are made?

Usually 4 or 8, occasionally 16, hopefully not 32 (although it’s been done, unfortunately)

How do radial cuts correct myopia?

The radial cuts gape, causing the peripheral cornea to bulge. This steepens the peripheral cornea, which in turn flattens the central cornea. Essentially, RK works by redistributing corneal power from the central cornea to the peripheral cornea.

In two words, what is the main long-term problem with RK?

‘Hyperopic drift’

What does this refer to?

To the fact that a significant proportion of RK eyes gradually become more and more hyperopic over time

According to the Prospective Evaluation of Radial Keratotomy (PERK) study, what percentage of RK eyes will manifest a diopter or more of hyperopic drift after 10 years?

Over 40!

What accounts for diurnal fluctuation?

Hypoxic edema. Closed eyelids during sleep deprive the cornea of O2, and the resulting hypoxia causes the incisions to swell a little. This swelling in turn induces increased flattening of the central cornea, resulting in more hyperopia. After several hours of increased O2 exposure while the eyes are open, the edema dissipates, and the excess hyperopia resolves.

Because of these (and other) issues, RK is considered ‘obsolete,’ and thus is no longer performed in the US
There is another procedure, similar to AK and LRI, that was at one time commonly used to correct astigmatism, but is rarely used today. What is it?
There is another procedure, similar to AK and LRI, that was at one time commonly used to correct astigmatism, but is rarely used today. What is it? Transverse keratotomy

(Note: ‘Transverse keratotomy’ is aka tangential keratotomy)
There is another procedure, similar to AK and LRI, that was at one time commonly used to correct astigmatism, but is rarely used today. What is it? Transverse keratotomy

In what fundamental way does transverse keratotomy differ from AK and LRI?
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In what fundamental way does transverse keratotomy differ from AK and LRI?

In terms of the shape of the incision--AK/LRI incisions are curved, whereas transverse keratotomy incisions are straight.
Incisional Corneal Refractive Surgery

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In what fundamental way does transverse keratotomy differ from AK and LRI?
In terms of the shape of the incision--AK/LRI incisions are curved, whereas transverse keratotomy incisions are straight
In what fundamental way does AK differ from LRI?

In terms of the location of the incision--AK incisions are made ~7 mm from the center of the cornea, whereas LRI incisions are made at the limbus.
In what fundamental way does AK differ from LRI? In terms of the location of the incision--AK incisions are made \( \sim 3.5 \) mm from the center of the cornea, whereas LRI incisions are made at the limbus location.
In what fundamental way does AK differ from LRI? In terms of the location of the incision--AK incisions are made ~3.5 mm from the center of the cornea, whereas LRI incisions are made at the limbus.
AK incisions

LR incisions

Limbal Relaxing Incisions

Incisions
In what fundamental way does AK differ from LRI? In terms of the location of the incision—AK incisions are made ~3.5 mm from the center of the cornea, whereas LRI incisions are made at the limbus.

(Note that this results in an AK optical zone of ~7 mm)
Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea?

Other

CXL

ICRS

CRI

SAI

CK

LASIK

Epi-LASIK

LASEK

PRK
Incisional Corneal Refractive Surgery

- Refractive Surgery
  - Corneal
    - Incisional
      - RK
      - AK
      - LRI
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other
      - CK
      - SAI
      - CRI
      - CXL
      - ICRS

Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea? The steep
Incisional Corneal Refractive Surgery

Refractive Surgery

Corneal

Incisional

Laser

Other

Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea?
The steep

Are they performed singularly, or in pairs?

Incisional

LRI

AK

RK

Laser

PRK

LASEK

Epi-LASIK

LASIK

SMILE

Other

CK

SAI

CRI

CXL

ICRS

To correct post-penetrating keratoplasty astigmatism
Incisional Corneal Refractive Surgery

Refractive Surgery

Corneal

Incisional
- RK
- AK
- LRI

Laser
- PRK
- LASEK
- Epi-LASIK
- LASIK
- SMILE

Other
- CK
- SAI
- CRI
- CXL
- ICRS

Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea?
The steep

Are they performed singularly, or in pairs?
In pairs, on opposite sides of the cornea
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Which is more commonly used today?

Incisional Corneal Refractive Surgery

Refractive Surgery

Corneal

Incisional

Laser

Other

RK

PRK

CK

SAI

AK

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CRI

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Epi-LASIK

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Which is more commonly used today?
LRIs, by a mile
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Are they performed singularly, or in pairs? In pairs, on opposite sides of the cornea

Which is more commonly used today? LRIs, by a mile

What is the typical context in which LRIs are used? They are usually performed at the time of cataract surgery, or shortly thereafter

What is the typical context in which AKs are used? To correct post-penetrating keratoplasty astigmatism
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Incisional Corneal Refractive Surgery

- RK
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- LRI

- PRK
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- Epi-LASIK
- LASIK
- SMILE

- CK
- SAI
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common eye surgery
Incisional Corneal Refractive Surgery

Refractive Surgery

Corneal Incisional

Laser

Other

Incisional

- RK
- AK
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Laser

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Refractive Surgery

Corneal

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What is the typical context in which AKs are used? To correct post-penetrating keratoplasty astigmatism

In treating post-PK astigmatism, where are the AK incisions placed? Either in the host vs donor cornea, or the PK incision itself
Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea?
The steep

Are they performed singularly, or in pairs?
In pairs, on opposite sides of the cornea

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Incisional Corneal Refractive Surgery

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Why not place the incisions in the host bed?
Are AK and LRI incisions placed on the steep, or the flat meridian of the cornea?
The steep

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Either in the donor cornea, or the PK incision itself

Why not place the incisions in the host bed?
Because doing so produces only a negligible effect on the astigmatism
What was the typical context in which transverse keratotomy was used?

Transverse keratotomy
What was the typical context in which transverse keratotomy was used?

It was used in conjunction with RK to correct the astigmatic portion of the RK pt’s refractive error. As RK fell out of favor, transverse keratotomy fell with it.
When AK and LRI incisions placed on the steep meridian of the cornea, what effect do they have on that meridian’s steepness?

They flatten it

What effect (if any) does placement of AK or LRI incisions have on the steepness of the meridian 90 degrees away (ie, the opposite meridian)?

They steepen it

What is the name for the phenomenon of incisions producing steepening in the opposite meridian?

Coupling

In this context, what is the coupling ratio?

It is an index of the relative flattening and steepening caused by the incisions. It is defined as the amount of flattening (in diopters) divided by the amount of steepening (again, in diopters).

What is the effect of the incisions on the spherical equivalent (SE) of the eye if the coupling ratio is…

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Incisional Corneal Refractive Surgery

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Corneal Coupling Effect

Before Corneal Incisions

MRx -3.00 + 2.00 x 090
Spherical Equivalent -1.50
K 45.00 x 090 / 43.00 x 180

Coupling
Corneal Coupling Effect

Before Corneal Incisions
MRx -3.00 + 2.00 x 090
Spherical Equivalent -1.50
K 45.00x090 / 43.00x180

After Corneal Incisions
MRx -1.50 spherical
Spherical Equivalent -1.50
K 44.00x090 / 44.00x180

Coupling
Incisional Corneal Refractive Surgery

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What is the most important factor in determining the coupling ratio of an AK/LRI procedure? The procedure itself. Specifically, the LRI procedure essentially always produces a ratio of 1.0, whereas results with the AK procedure are more variable (but usually ~1.0).
Incisional Corneal Refractive Surgery

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With respect to AK, what factors influence the coupling ratio?
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Incisional Corneal Refractive Surgery

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With respect to AK, what factors influence the coupling ratio?
--The length of the incisions.
--The depth of the incisions.
--The size of the [two words].
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With respect to AK, what factors influence the coupling ratio?

--The length of the incisions

--The depth of the incisions

--The size of the optical zone
Incisional Corneal Refractive Surgery

With regard to AKs and LRIs, what factors influence their effectiveness?

---

Should incisional correction of astigmatism be based on a manifest refraction, or corneal topography? It depends. AKs performed as a stand-alone procedure should be based on the manifest refraction, so as to offset both corneal and lenticular astigmatism. In contrast, LRIs performed at the time of cataract surgery should be based on corneal topography, because any astigmatism owing to the lens will be dealt with by the CE surgery.

When marking the pt's eye prior to making the incisions, how should the pt be positioned? Seated upright. Why seated upright? In a word—cyclotorsion. When a pt lies down, their eyes rotate up to 15°. Thus, assuming the pt was refracted and had her pre-op topography performed while seated, incisions based on the position of the eye while the pt is supine will be off by up to 15°.
Incisional Corneal Refractive Surgery

With regard to AKs and LRIs, what factors influence their effectiveness?
--Pt age
--The number of incisions
--The length of the incisions
--The depth of the incisions

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Incisional Corneal Refractive Surgery

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In a word—cyclotorsion. When a pt lies down, their eyes rotate up to 15°. Thus, assuming the pt was refracted and had her pre-op topography performed while seated, incisions based on the position of the eye while the pt is supine will be off by up to 15°.

Other

CK
ICRS
CXL
SAI
CRI
ICRS
LRI effect as a function of incision length

Larger Incisions = More Flattening

Smaller Incisions = Less Flattening

This cornea still has 1 diopter of residual astigmatism

Larger Incisions = More Flattening

This cornea has no residual astigmatism
Incisional Corneal Refractive Surgery

With regard to **AKs and LRIs**, what factors influence their effectiveness?

Speaking of effectiveness...For a given incision length and depth, which has more effect on astigmatism: LRIs, or AKs?

--The depth of the incisions

With regard to **AKs and LRIs**, what factors influence their effectiveness?

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**Corneal**

- **Incisional**
  - RK
  - AK
  - LRI

- **Laser**
  - PRK
  - LASEK
  - Epi-LASIK
  - LASIK
  - SMILE

- **Other**
  - CK
  - SAI
  - CRI
  - CXL
  - ICRS

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When marking the pt's eye prior to making the incisions, how should the pt be positioned?

Seated upright

Why seated upright?

In a word—*cyclotorsion*. When a pt lies down, their eyes rotate up to 15°. Thus, assuming the pt was refracted and had her pre-op topography performed while seated, incisions based on the position of the eye while the pt is supine will be off by up to 15°.

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Speaking of effectiveness...For a given incision length and depth, which has more effect on astigmatism: LRIs, or AKs?

Because they are more centrally located, AK incisions have a greater effect.
Incisional Corneal Refractive Surgery

With regard to **AKs and LRIs**, what factors influence their effectiveness?

Speaking of effectiveness... For a given incision length and depth, which has more effect on astigmatism: LRIs, or AKs? Because they are more centrally located, incisions have a greater effect centrally vs peripherally. --The depth of the incisions.

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Should incisional correction of astigmatism be based on a manifest refraction, or corneal topography? It depends. AKs performed as a stand-alone procedure should be based on the manifest refraction, so as to offset both corneal and lenticular astigmatism. In contrast, LRIs performed at the time of cataract surgery should be based on corneal topography, because any astigmatism owing to the lens will be dealt with by the CE surgery.

When marking the pt's eye prior to making the incisions, how should the pt be positioned? Seated upright. Why seated upright? In a word—cyclotorsion. When a pt lies down, their eyes rotate up to 15°. Thus, assuming the pt was refracted and had her pre-op topography performed while seated, incisions based on the position of the eye while the pt is supine will be off by up to 15°.

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Incisional Corneal Refractive Surgery

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Corneal Refractive Surgery

- Incisional
  - RK
  - AK
  - LRI

- Laser
  - PRK
  - LASEK
  - Epi-LASIK
  - LASIK
  - SMILE

- Other
  - CK
  - SAI
  - CRI
  - CXL
  - ICRS
Astigmatic keratotomy effect as a function of incision location
Incisional Corneal Refractive Surgery

With regard to AKs and LRIs, what factors influence their effectiveness?
--Pt age
--The number of incisions
--The length of the incisions
--The depth of the incisions

Should incisional correction of astigmatism be based on a manifest refraction, or corneal topography?

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