

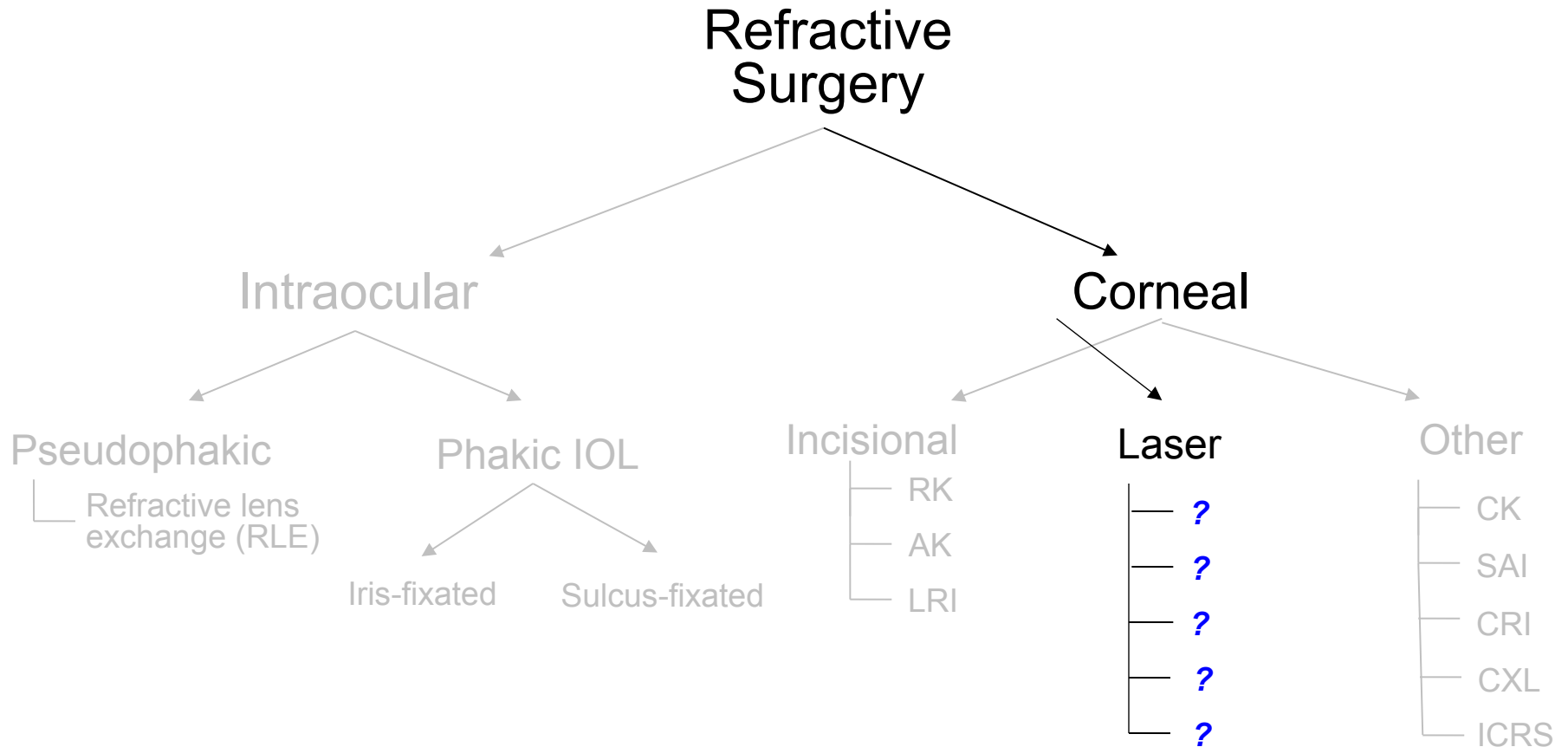


Laser Vision Corrections

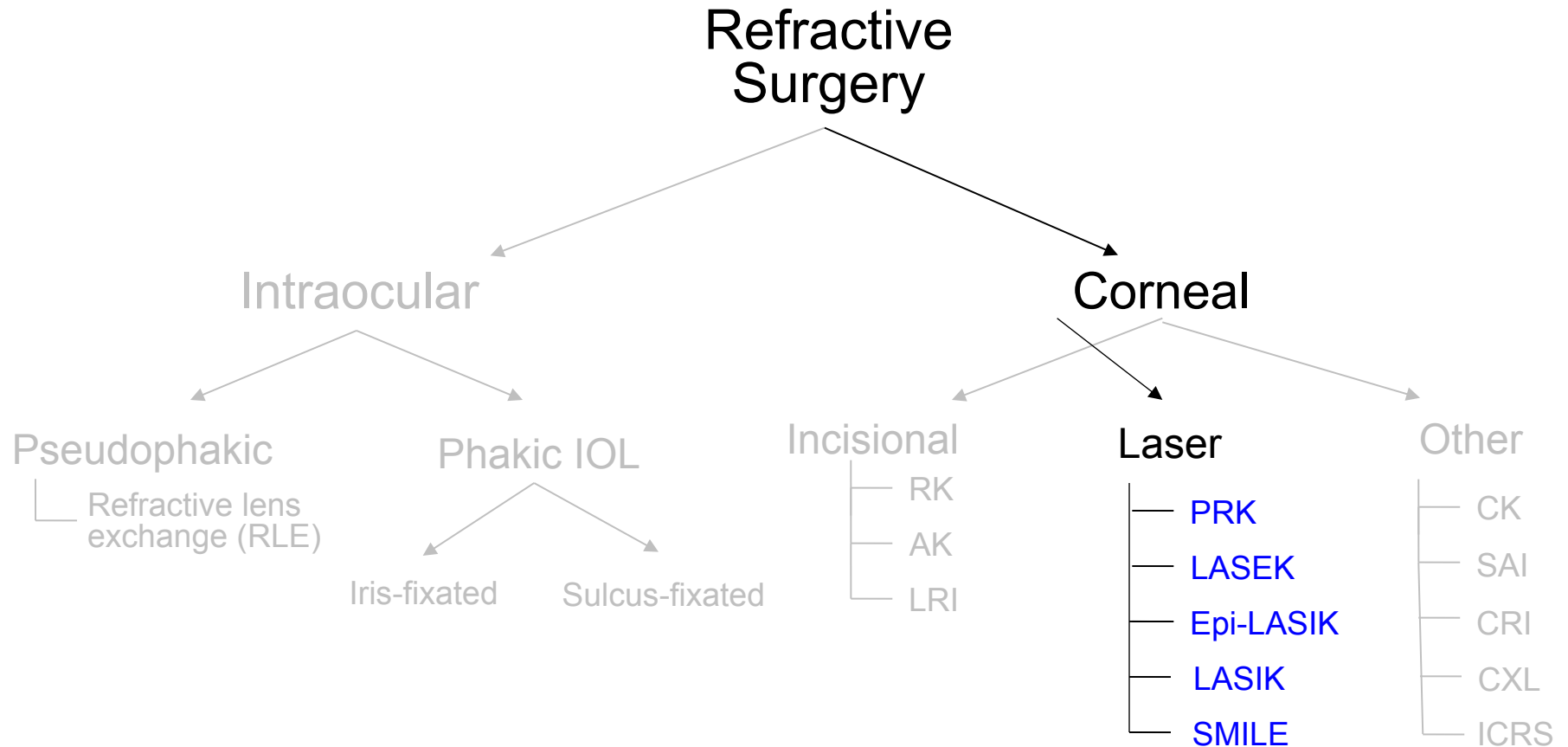
KONSTANTINA J.KOUFALA



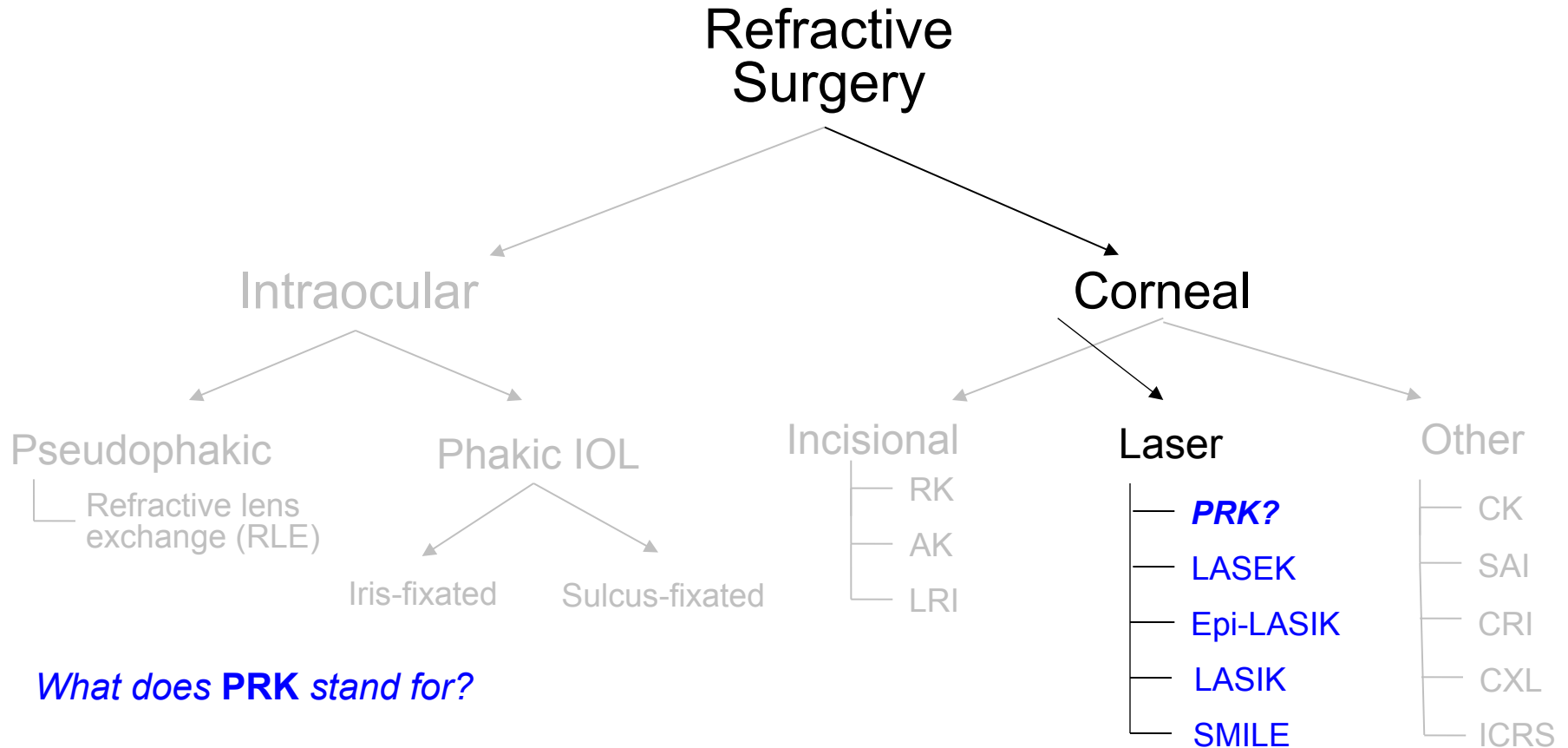
Photoablative Refractive Surgery



Photoablative Refractive Surgery

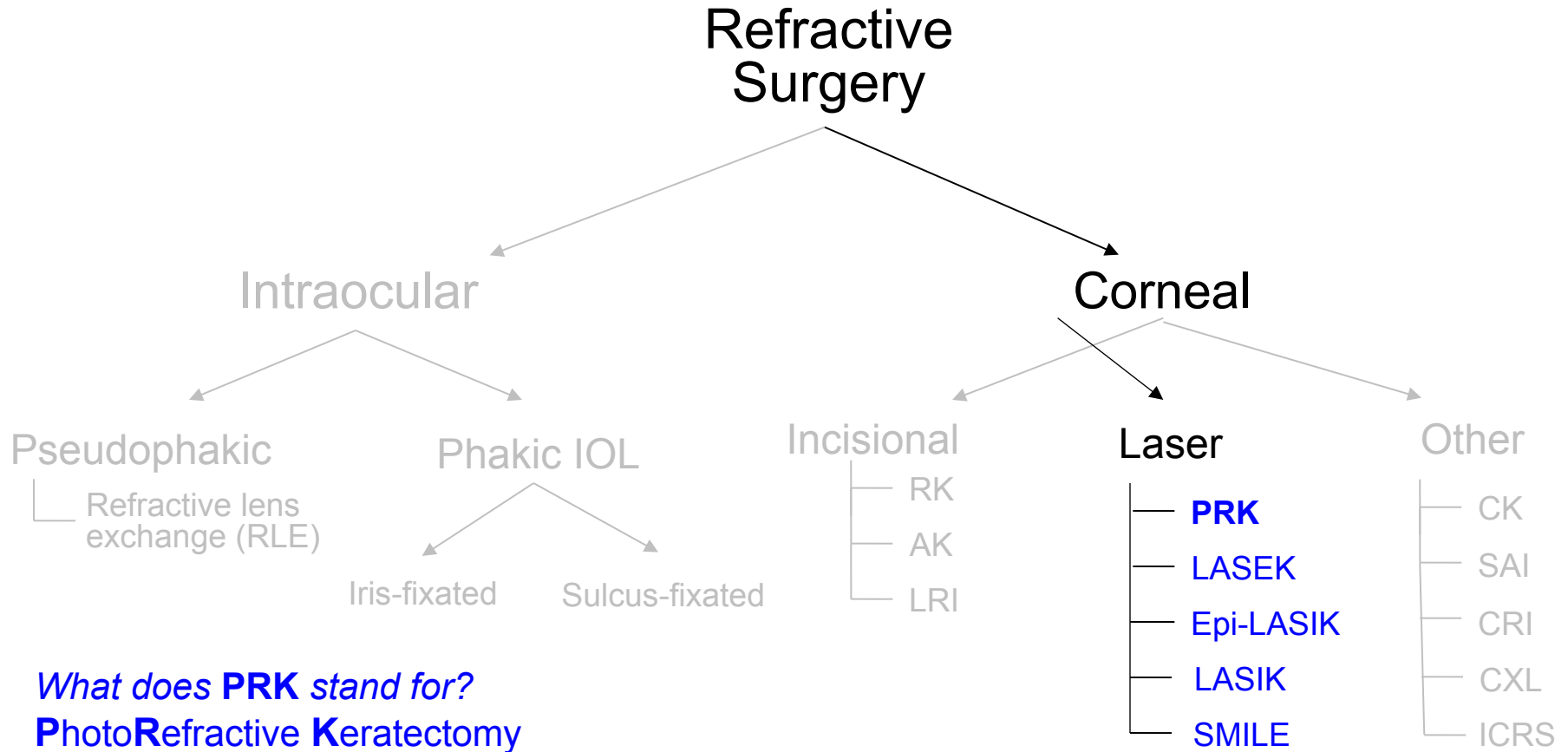


Photoablative Refractive Surgery

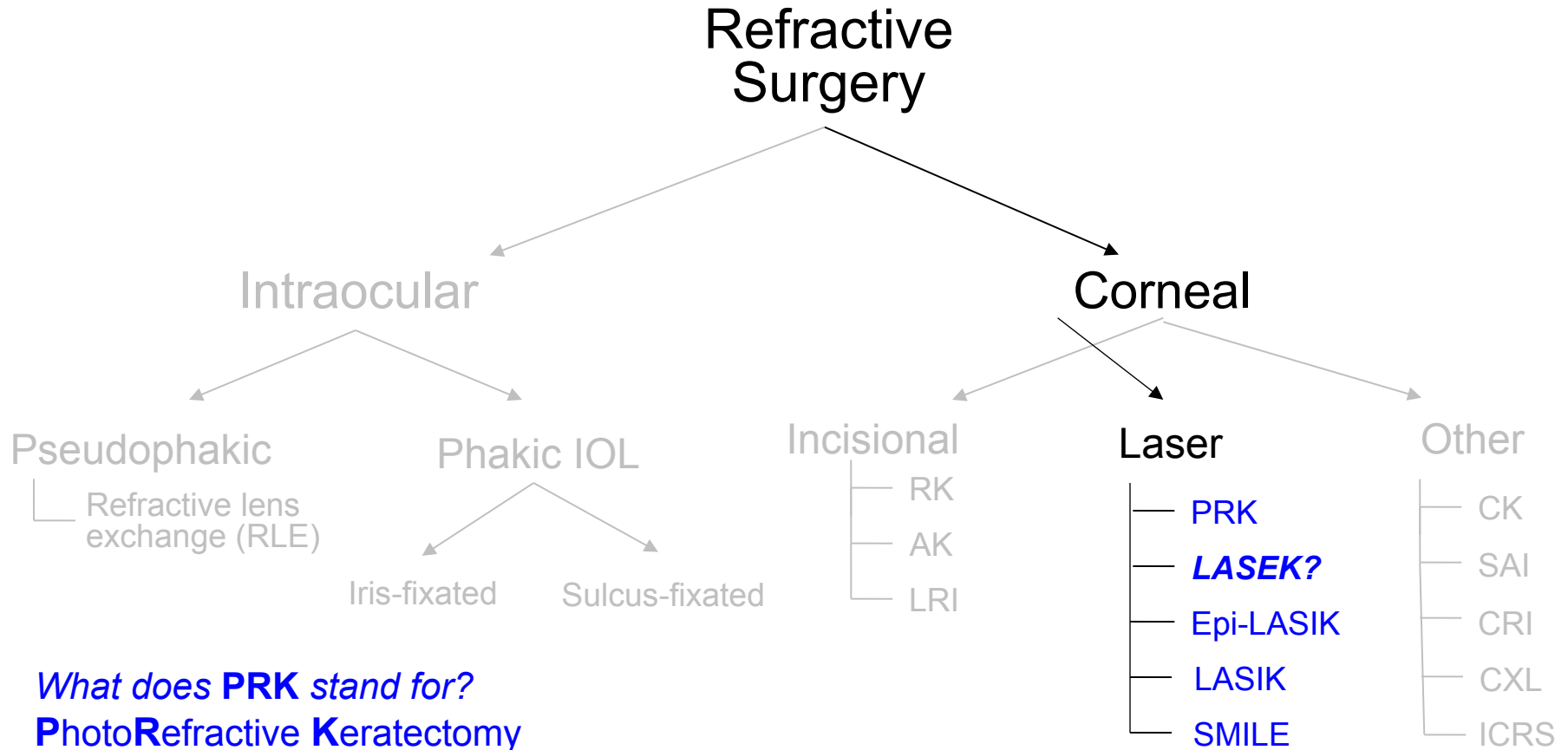


*What does **PRK** stand for?*

Photoablative Refractive Surgery



Photoablative Refractive Surgery

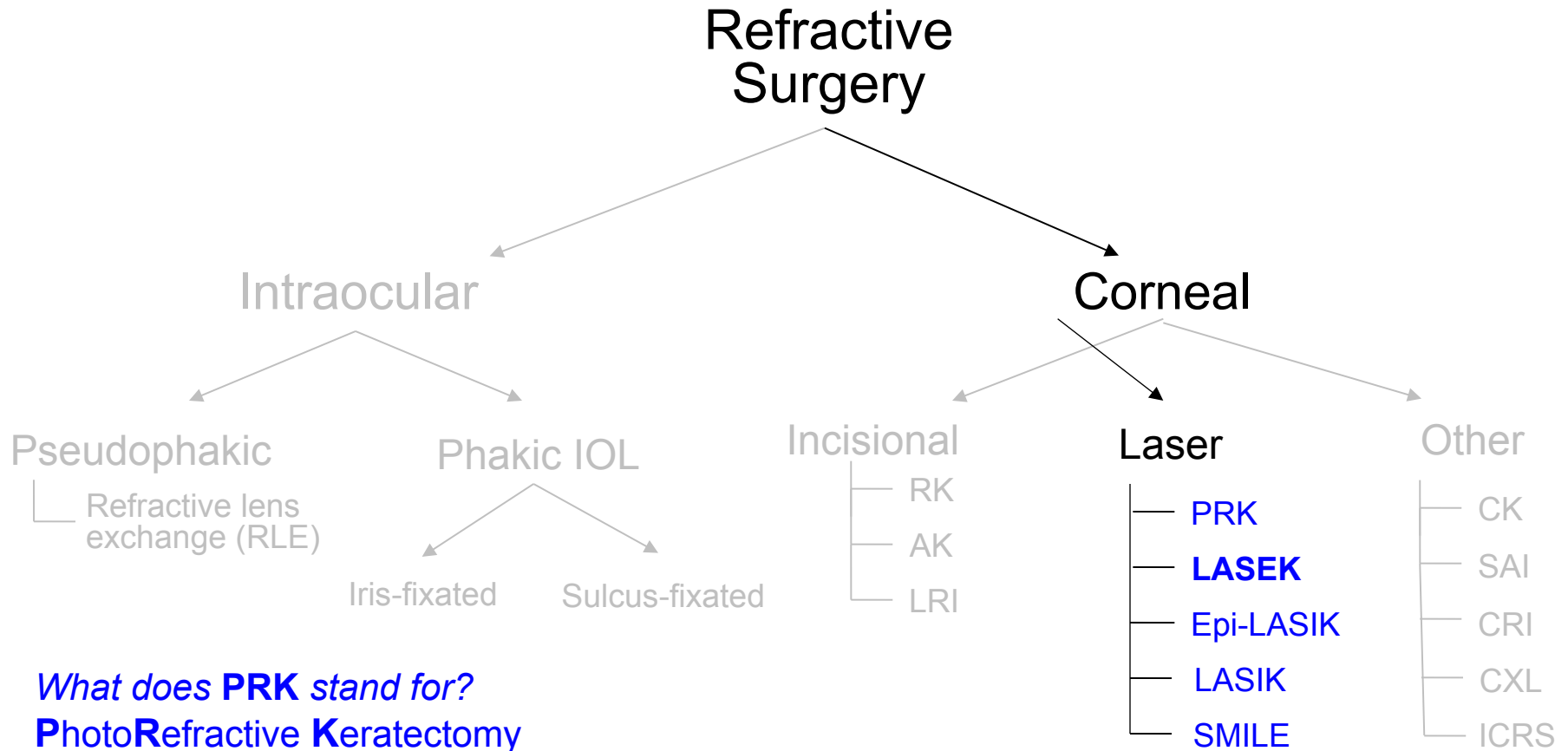


*What does **PRK** stand for?*

PhotoRefractive Keratectomy

*What does **LASEK** stand for?*

Photoablative Refractive Surgery



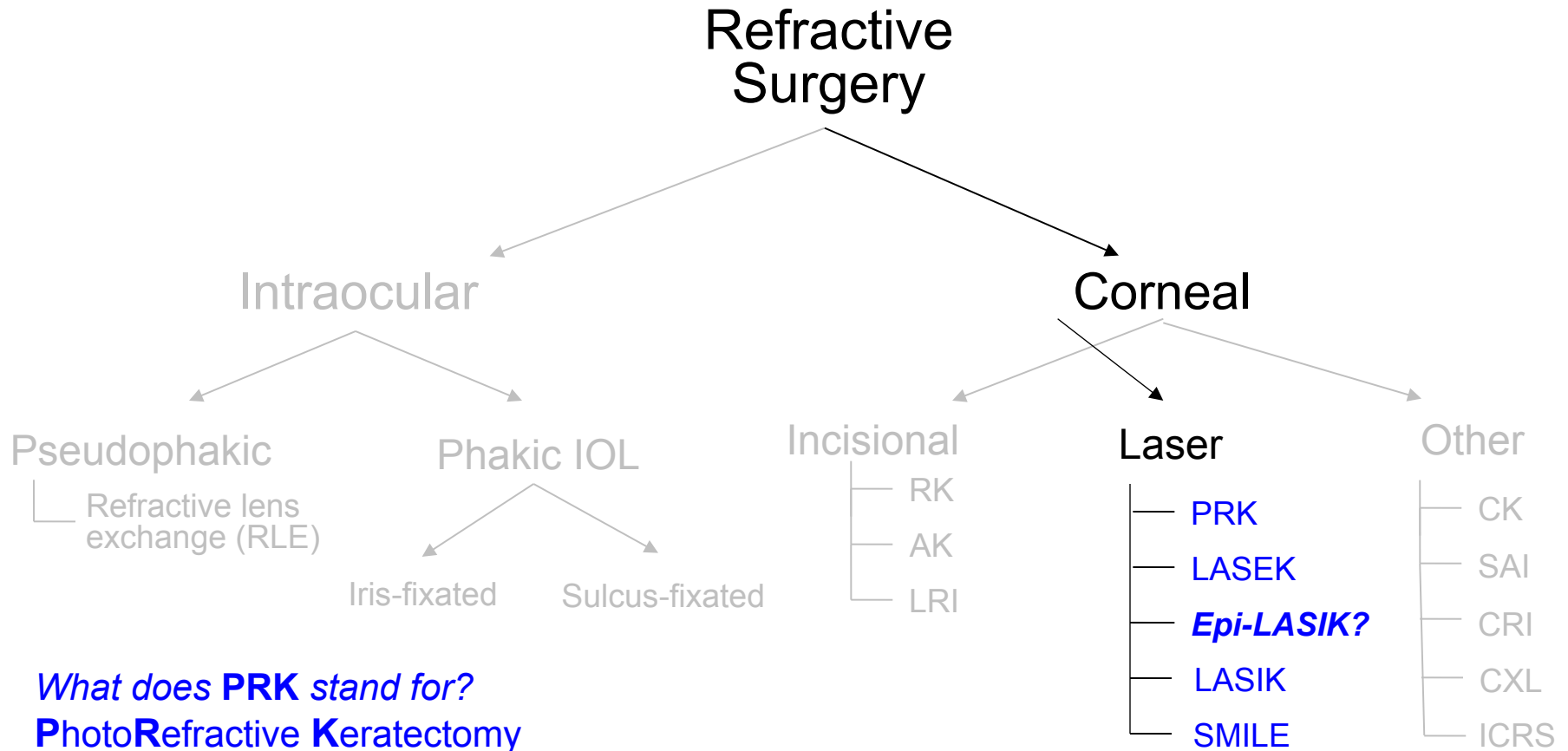
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LASer SubEpithelial Keratomileusis

Photoablative Refractive Surgery



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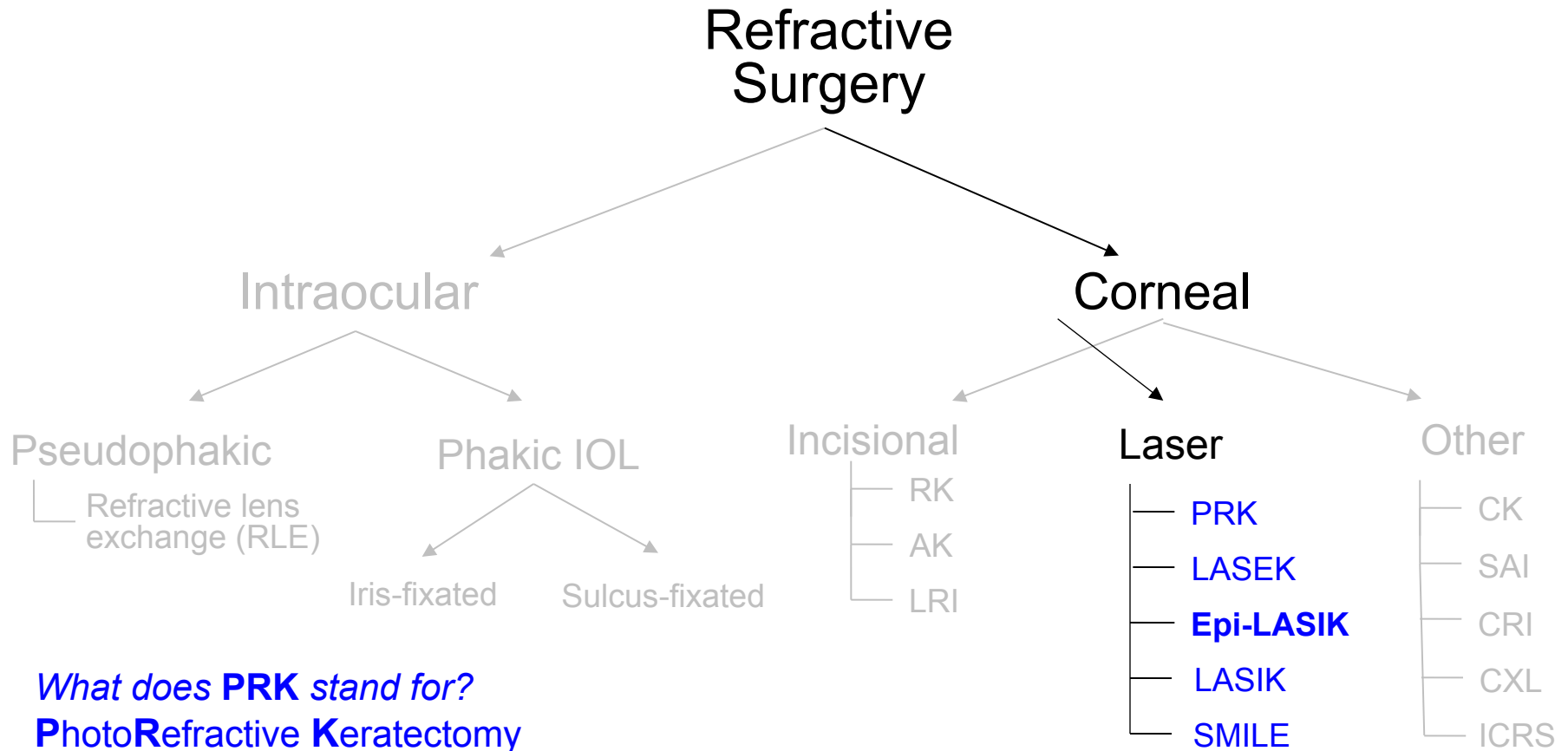
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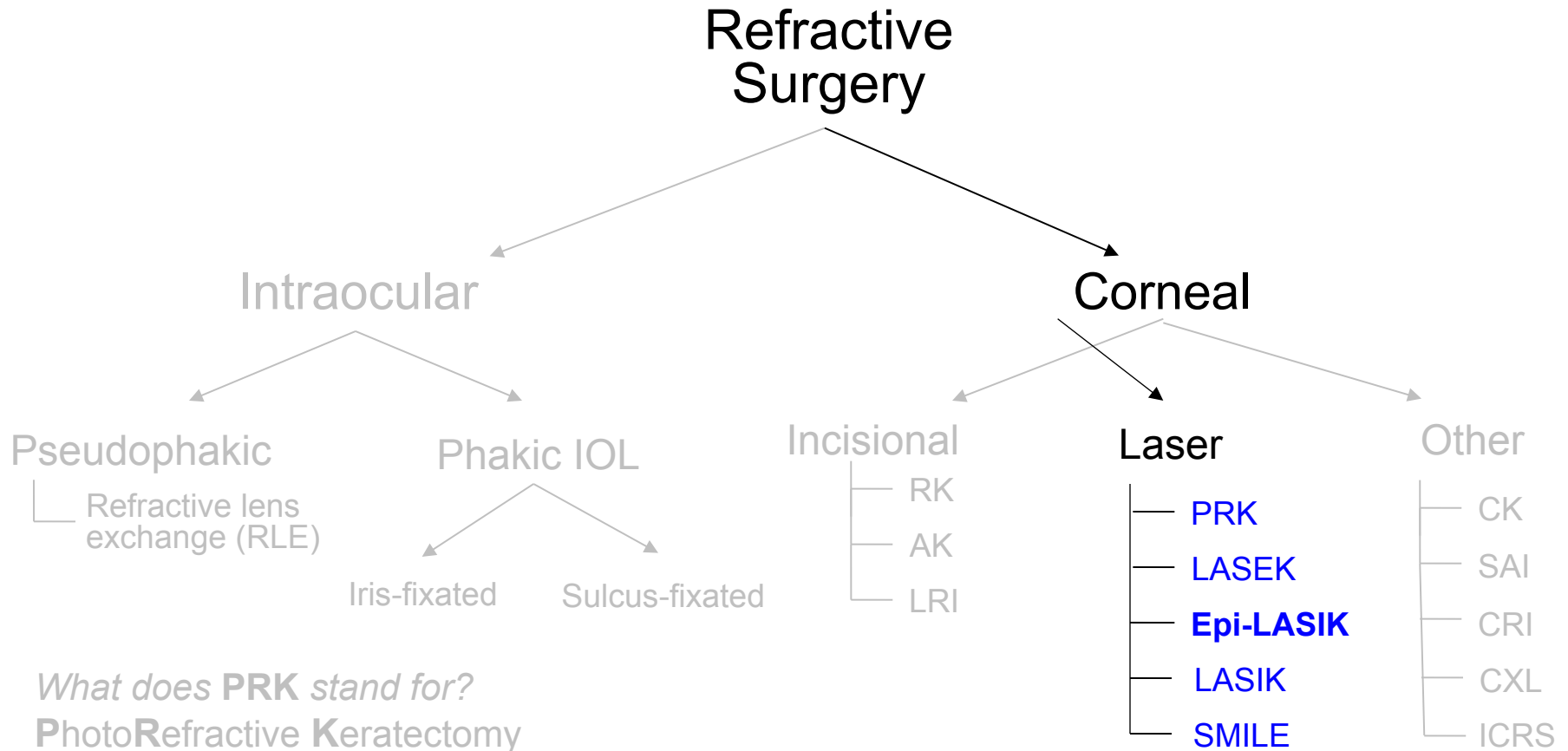
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Epipolis LASer In-situ Keratomileusis

Photoablative Refractive Surgery



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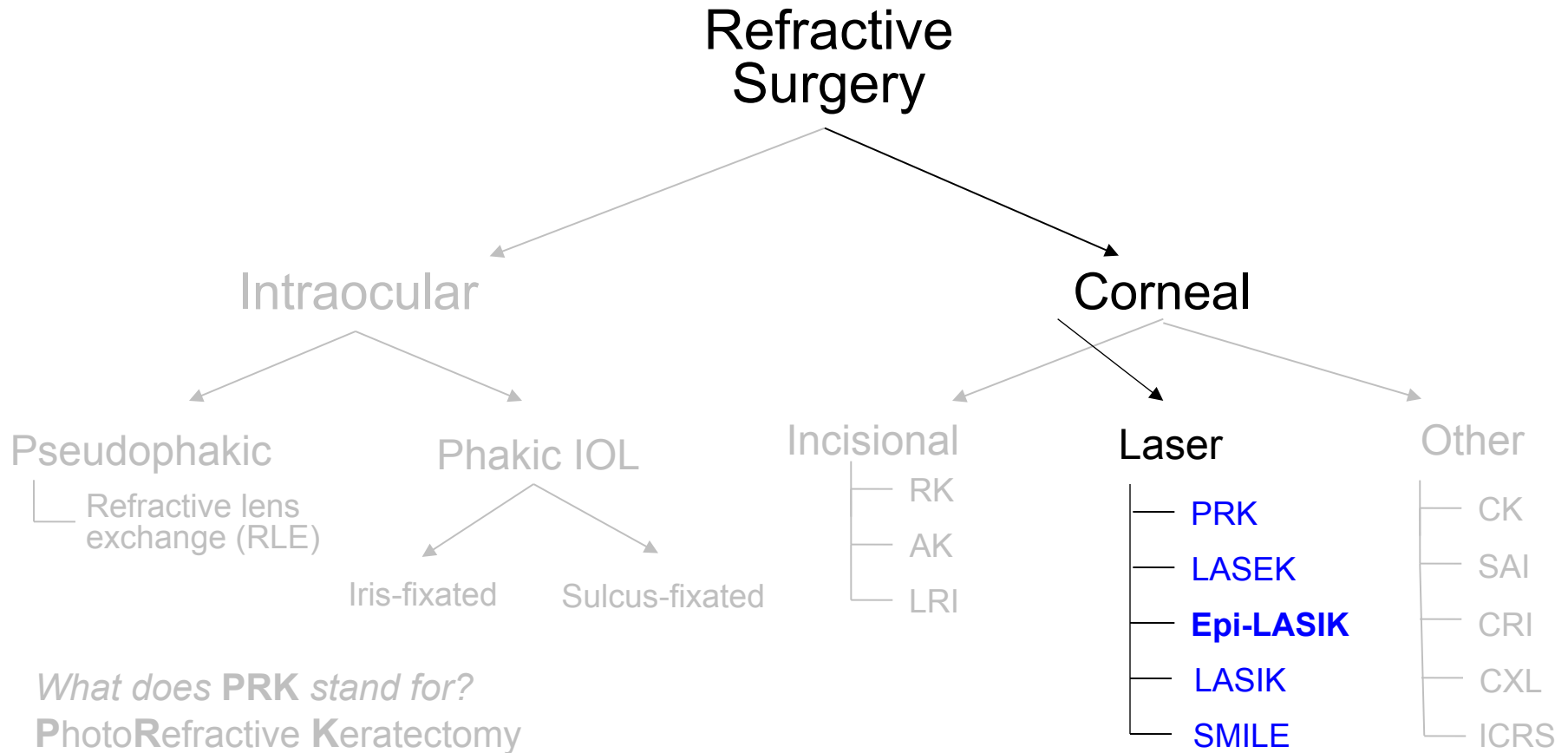
LASer SubEpithelial Keratomileusis

What does **Epi-LASIK** stand for?

Epipoli

What does **Epi**polis mean?

Photoablative Refractive Surgery



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PhotoRefractive Keratectomy

What does **LASEK** stand for?

LASer SubEpithelial Keratomileusis

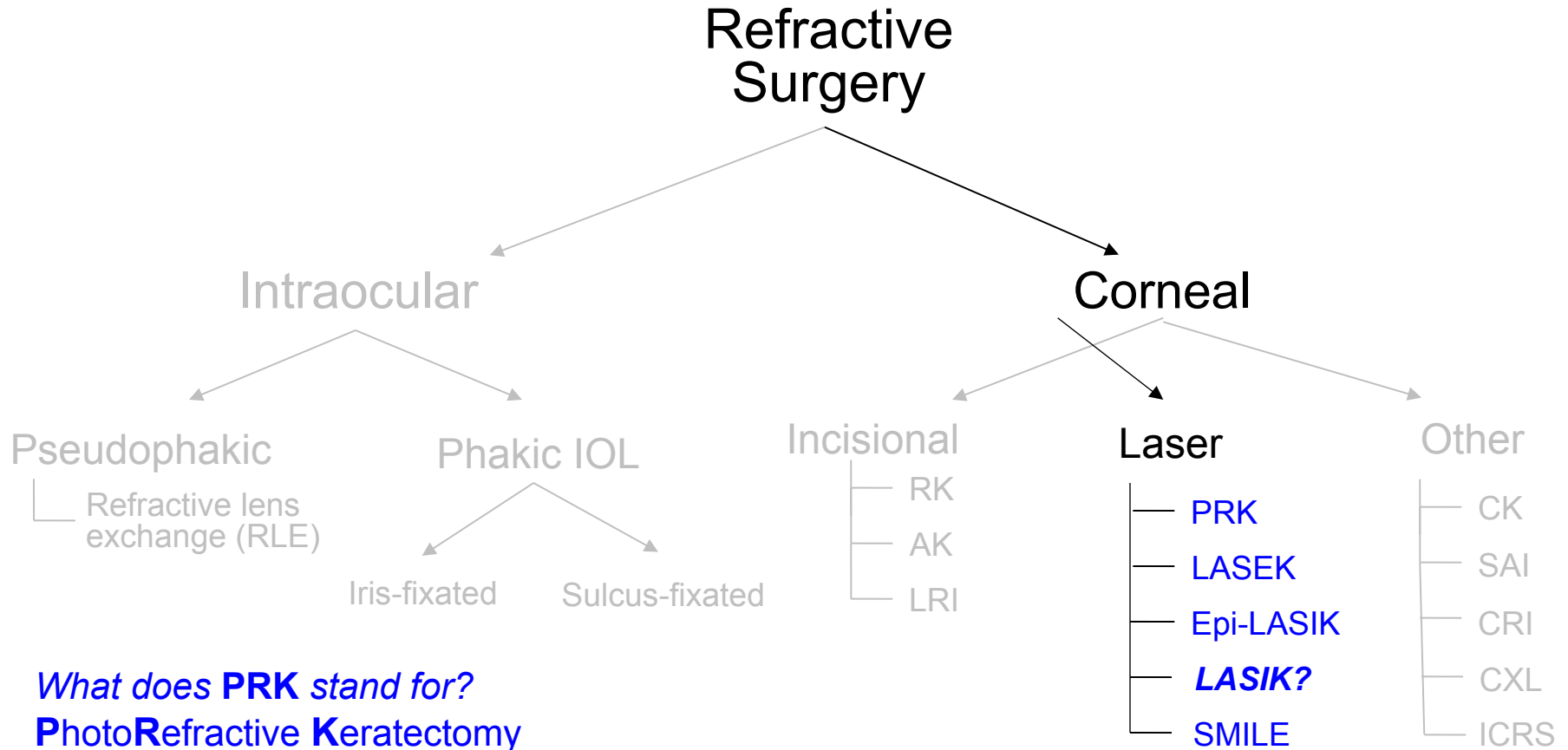
What does **Epi-LASIK** stand for?

Epipoli

What does **Epi**polis mean?

It is a Greek word meaning 'superficial'

Photoablative Refractive Surgery



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PhotoRefractive Keratectomy

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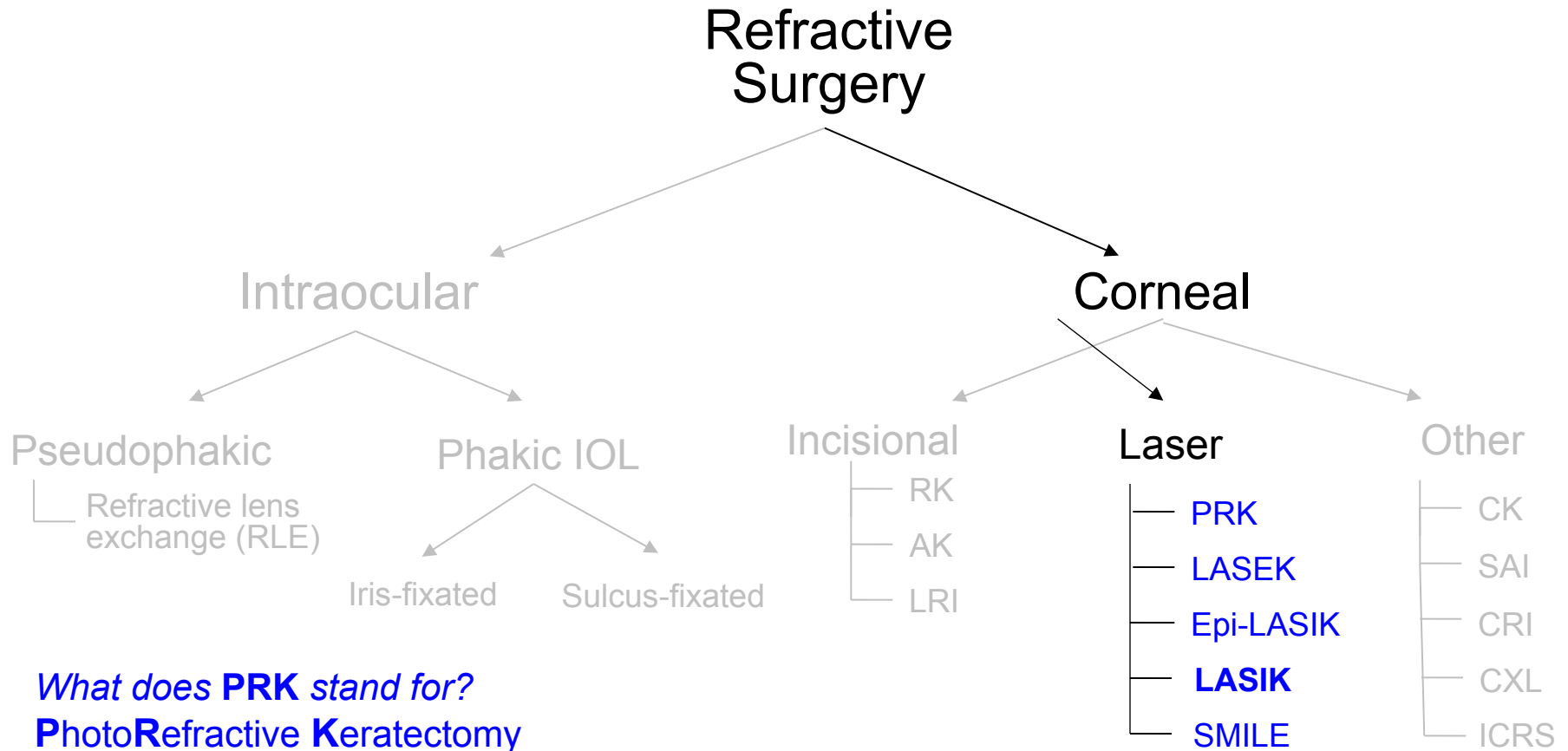
LASer SubEpithelial Keratomileusis

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Photoablative Refractive Surgery



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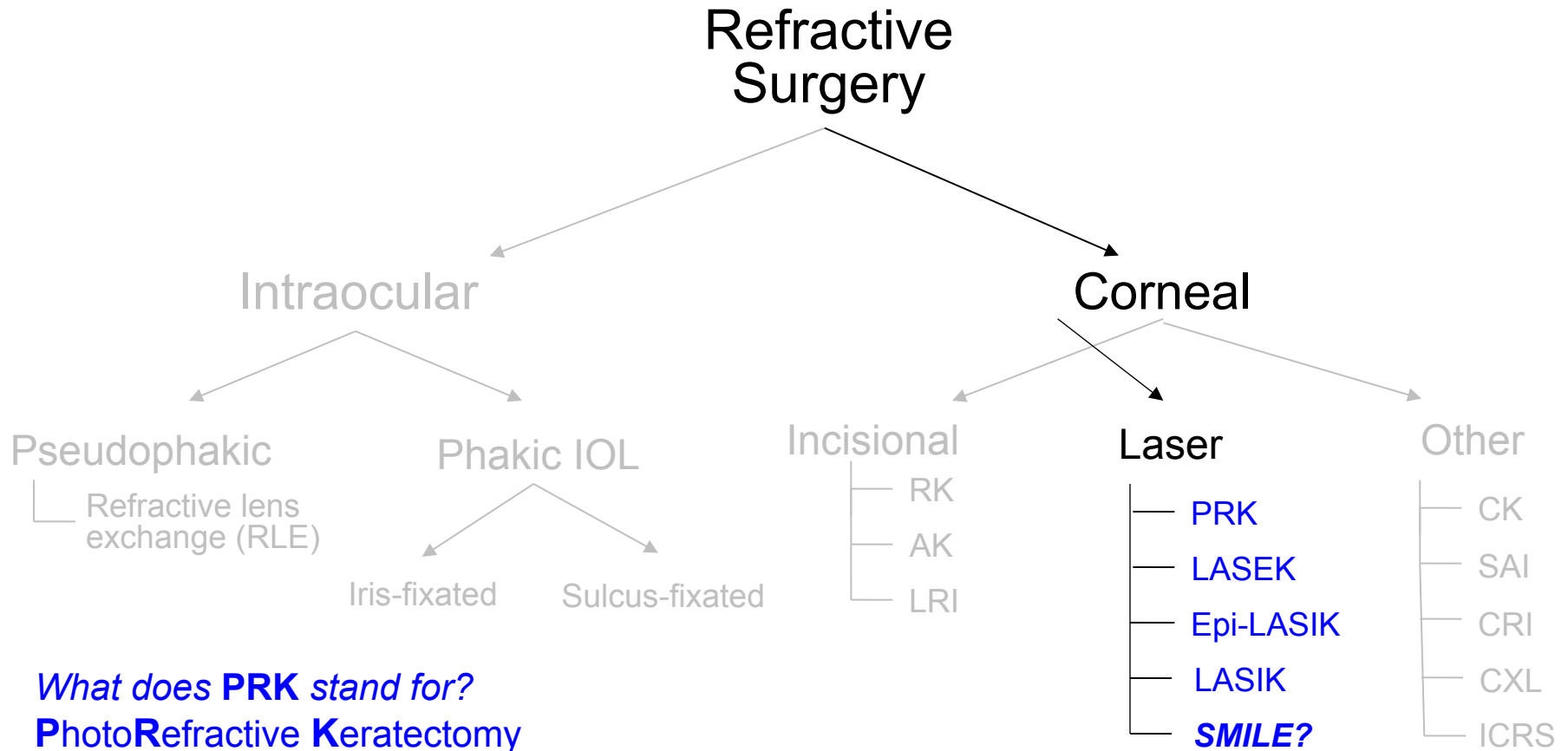
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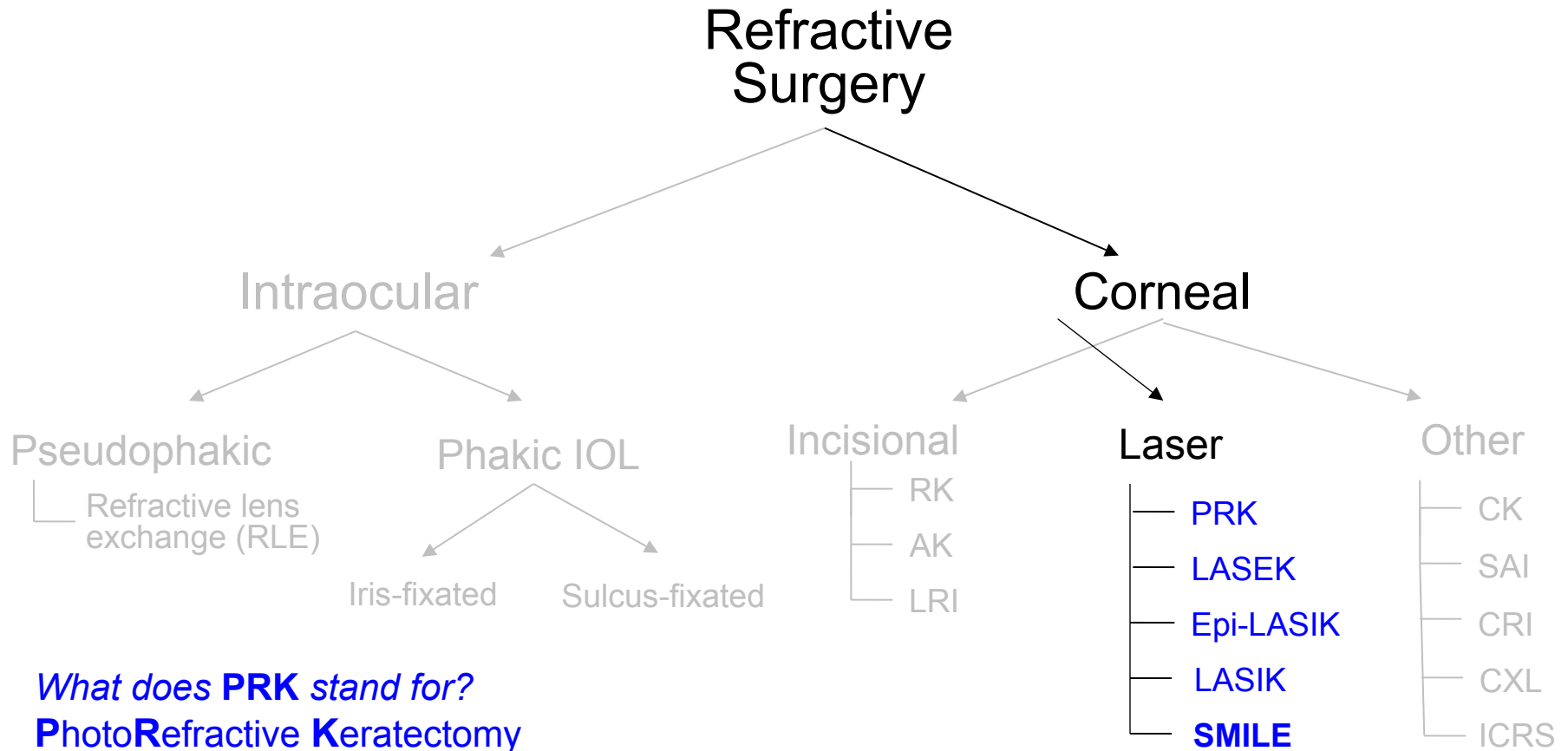
Epipolis LASer In-situ Keratomileusis

*What does **LASIK** stand for?*

LASer In-situ Keratomileusis

*What does **SMILE** stand for?*

Photoablative Refractive Surgery



*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

Photoablative Refractive Surgery

Refractive Surgery

Intraocular

Pseudophakic

Refractive lens

Phakic IOL

Incisional

RK

Corneal

Laser

PRK

LASEK

Epi-LASIK

LASIK

SMILE

Other

CK

SAI

CRI

CXL

ICRS

SMILE doesn't 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 of tissue (called a *lenticule*), which is then removed en bloc. In other words, while SMILE results in a loss of corneal tissue, that tissue is **not** ablated.

Photoablative Refractive Surgery

Excimer laser

Corneal

Laser

PRK

LASEK

Epi-LASIK

LASIK

Other

CK

SAI

CRI

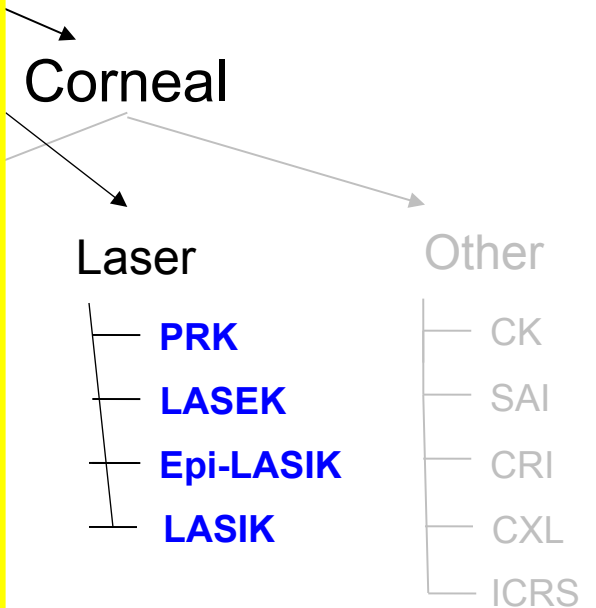
CXL

ICRS

Photoablative Refractive Surgery

Excimer laser

It is a portmanteau of the term **exci**-ted di-**mer**

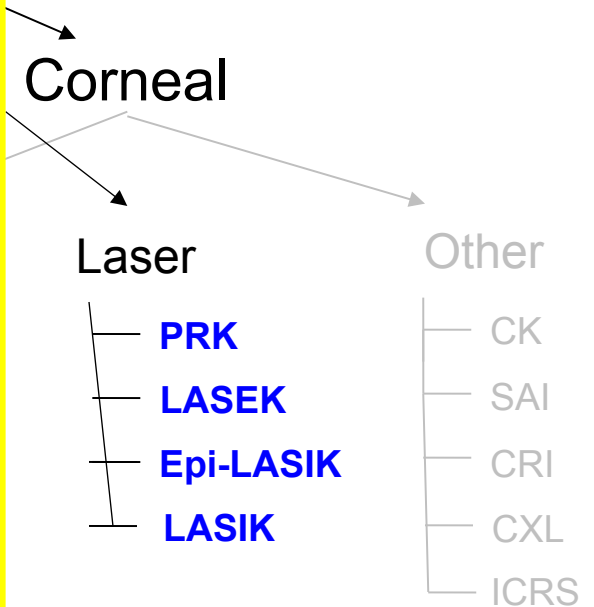


Photoablative Refractive Surgery

Excimer laser

It is a portmanteau of the term **exci**-ted di-**mer**

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



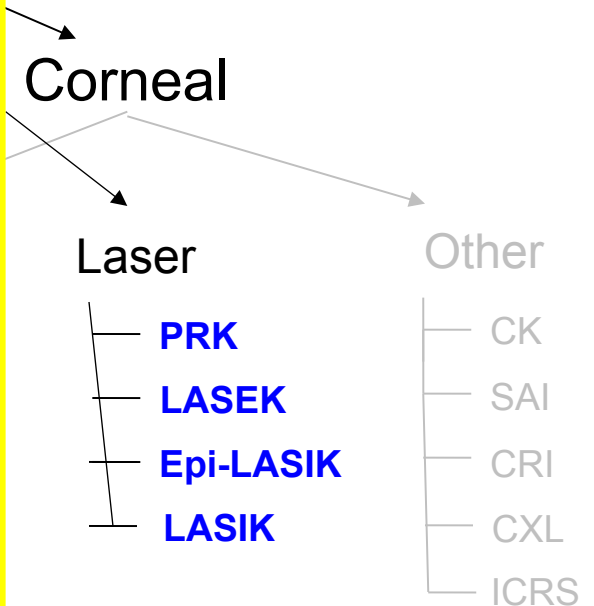
Photoablative Refractive Surgery

Excimer laser

It is a portmanteau of the term **exci**-ted di-**mer**

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

Argon-fluoride



Photoablative Refractive Surgery

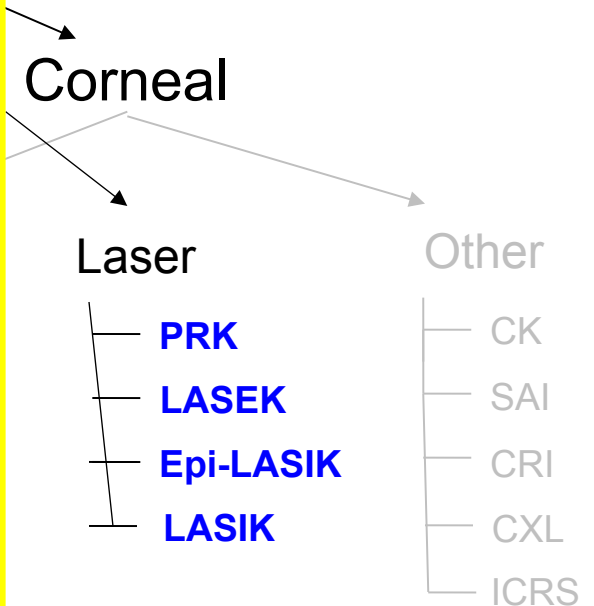
An **excimer** laser

It is a portmanteau of the term **exci**-ted di-**mer**

The active medium in an excimer consists of combination of two elemental gases:

Argon-fluoride

The wavelength of light is 193 nm UV



Photoablative Refractive Surgery

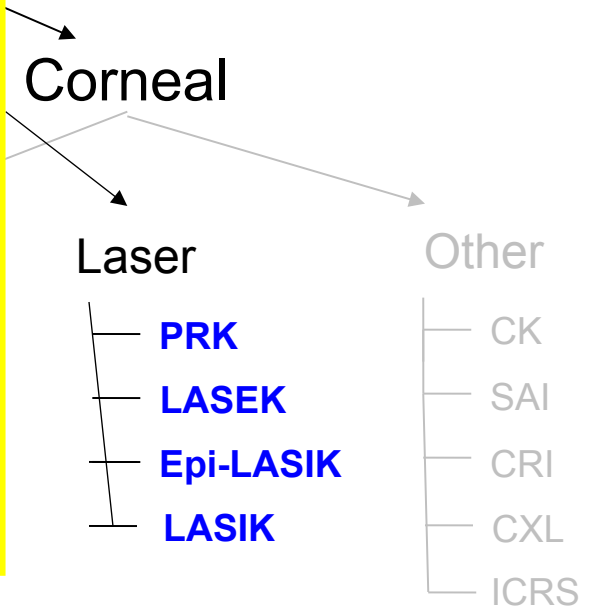
Excimer laser

It is a portmanteau of the term **exci**-ted di-**mer**

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

Argon-fluoride *wavelength* 193 nm UV

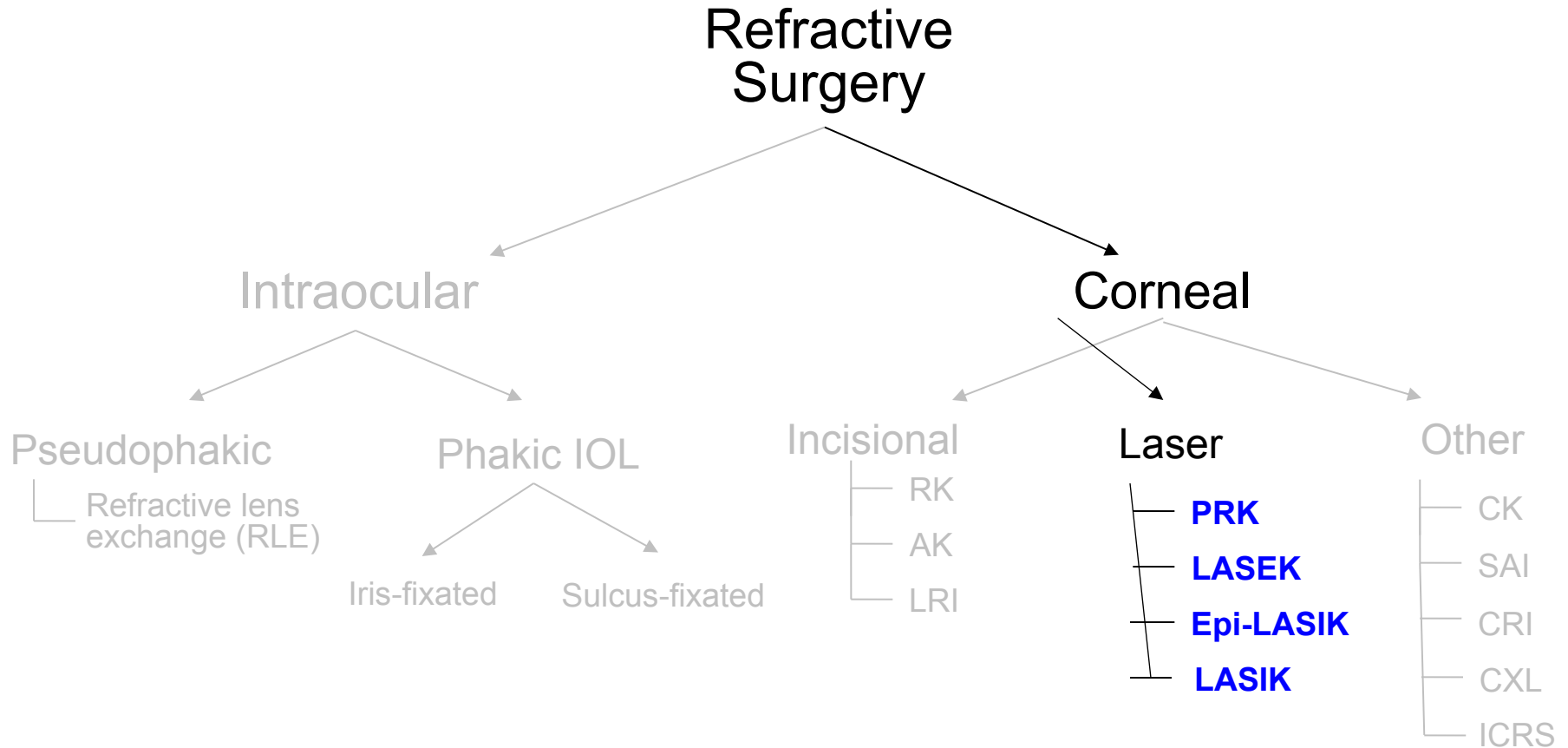
Light of this wavelength does not penetrate tissue, which makes it perfect for surface ablation and this form of radiation is not mutagenic



There are three subtypes of photoablating lasers--

- Flying spot
- Broad beam
- Scanning slit

Photoablative Refractive Surgery



The Munnerlyn Formula:

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

Photoablative Refractive Surgery

Refractive Surgery

The Munnerlyn formula give us:

The amount of central corneal tissue that must be removed to correct a given amount of myopia

Iris-fixated

Sulcus-fixated

LRI

LASEK

Epi-LASIK

LASIK

SAI

CRI

CXL

ICRS

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Photoablative Refractive Surgery

Refractive Surgery

The Munnerlyn formula give us:

The amount of central corneal tissue that must be removed to correct a given amount of myopia

By the Munnerlyn formula we realize:

— Intra-fixed

— Cornea-fixed

— LRI

Epi-LASIK

LASIK

— CRI

— CXL

— ICRS

The Munnerlyn Formula:

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

Photoablative Refractive Surgery

Refractive Surgery

In words, what does the Munnerlyn formula tell us?

The amount of central corneal tissue that must be removed to correct a given amount of myopia

By the Munnerlyn formula we realize :

That the amount of tissue which must be removed is a function of the square of the size of the optical zone

Iris-fixated

Sulcus-fixated

LRI

LASEK

Epi-LASIK

LASIK

SAI

CRI

CXL

ICRS

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

Refractive Surgery

In words, what does the Munnerlyn formula tell us?

The amount of central corneal tissue that must be removed to correct a given amount of myopia

What conundrum is highlighted by the Munnerlyn formula?

The fact that the amount of tissue that must be removed is a function of the square of the size of the optical zone

So what? Why not just make the optical zone very small, and thereby minimize tissue removal?

Because **the smaller the optical zone, the greater the incidence and severity of vision-degrading phenomena such as haloes and glare**

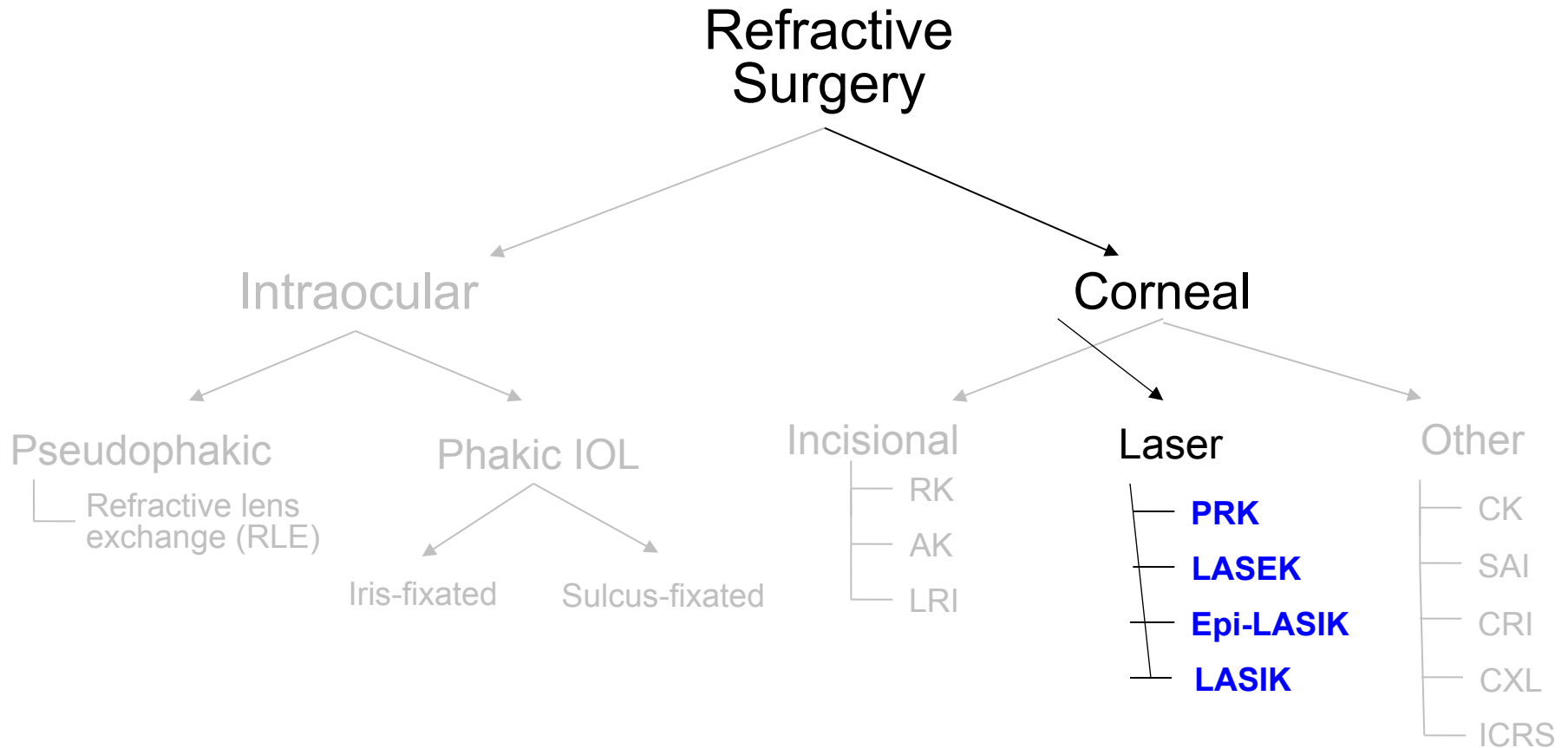
*In order to keep haloes and glare at a low level, the smallest optical-zone diameter generally considered acceptable in myopic photoablative refractive surgery is **6 mm!!!***

ICRS

The Munnerlyn Formula:

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

Photoablative Refractive Surgery

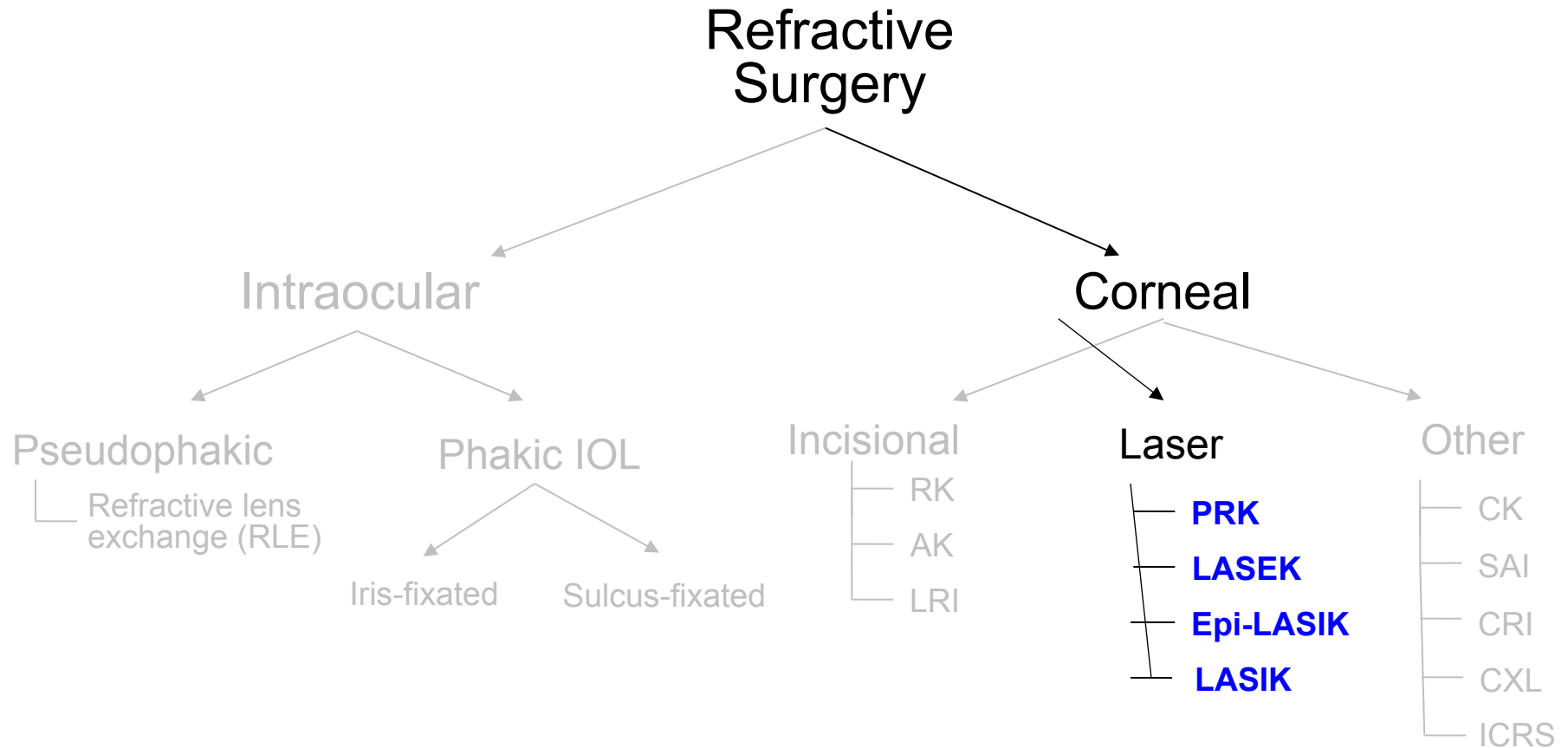


*Does the Munnerlyn formula apply to **hyperopic** photoablative refractive surgery?*

The Munnerlyn Formula:

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

Photoablative Refractive Surgery



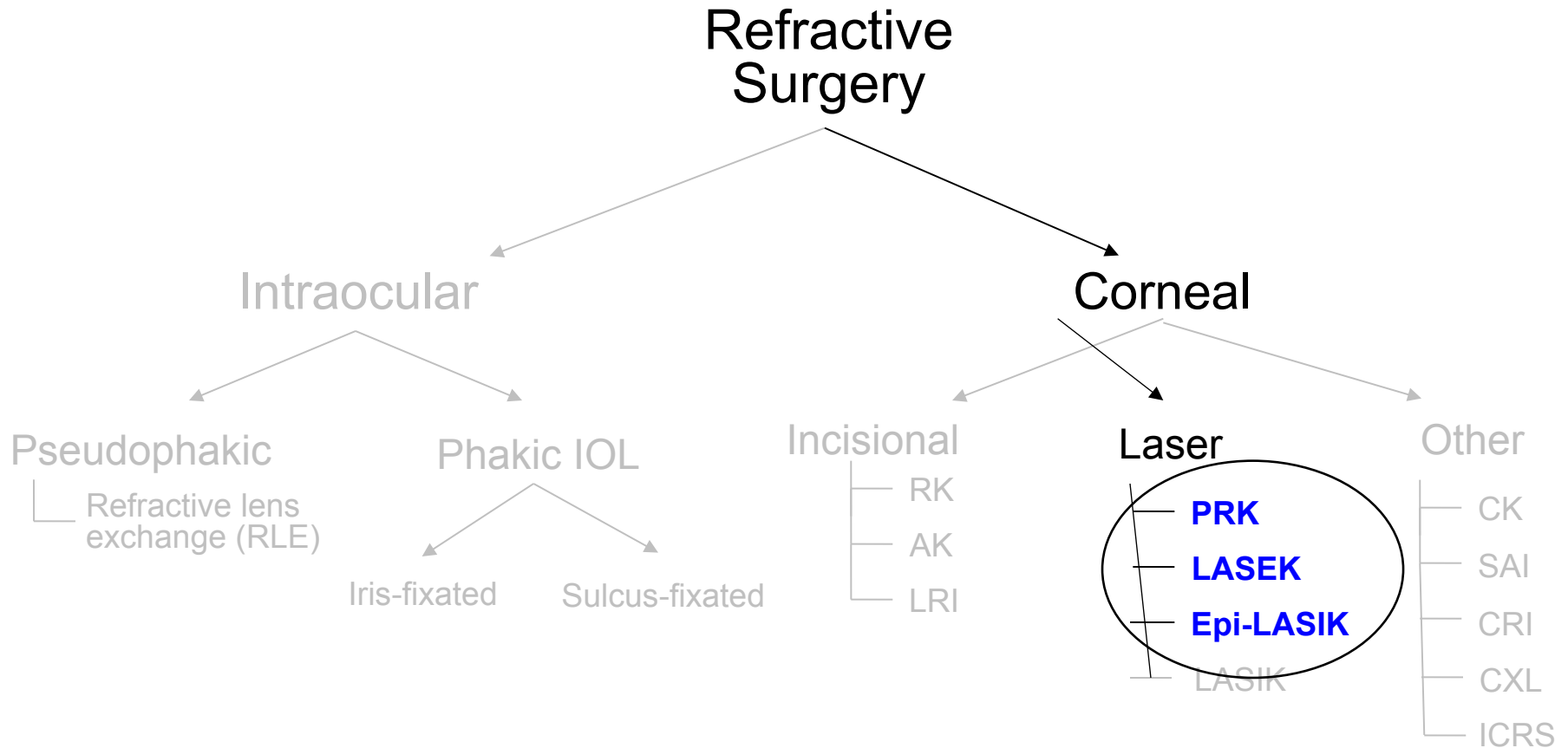
*Does the Munnerlyn formula apply to **hyperopic** photoablative refractive surgery? **No!***

The Munnerlyn Formula:

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

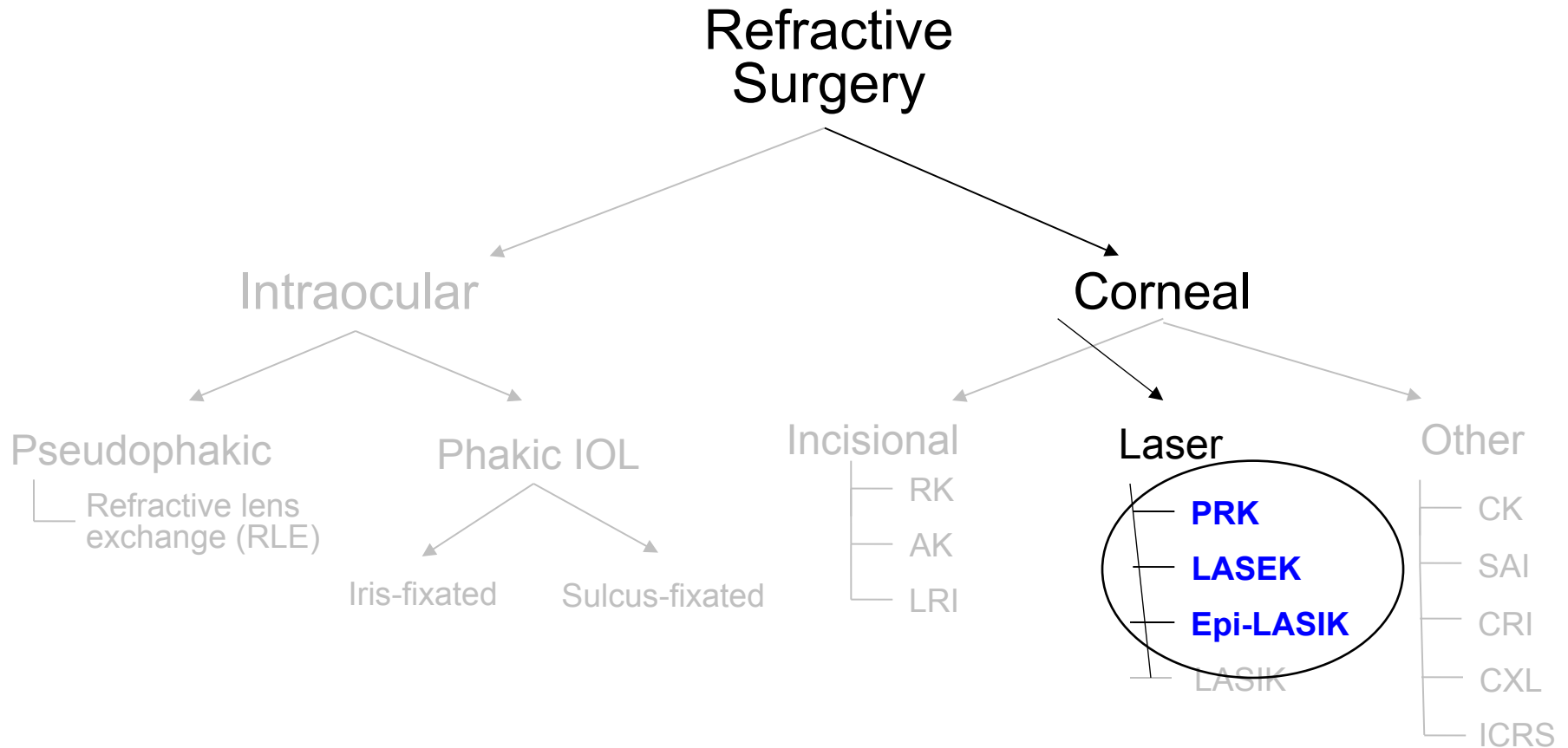
hyperopia

Photoablative Refractive Surgery



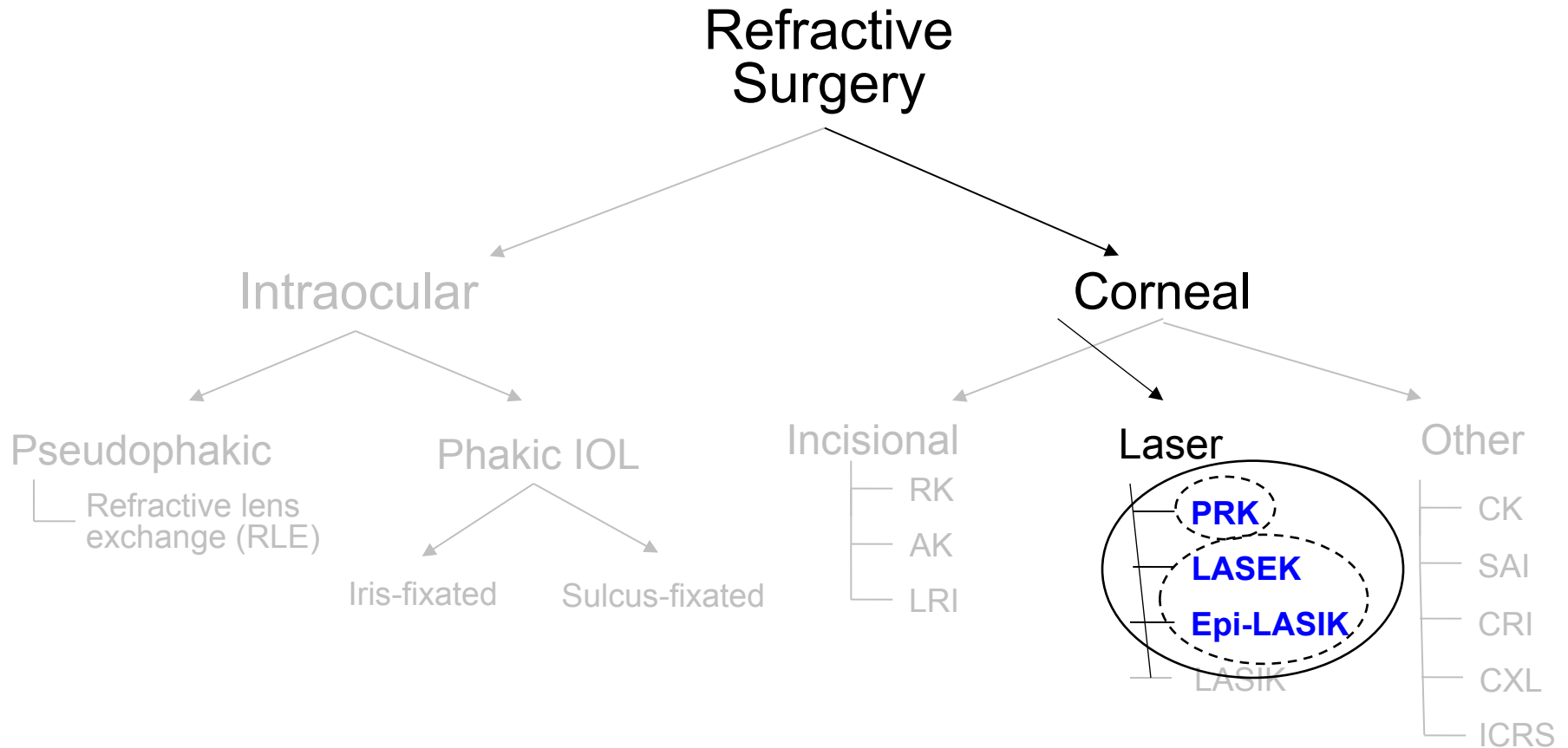
How do the surface-ablation procedures differ from one another?

Photoablative Refractive Surgery



How do the surface-ablation procedures differ from one another?
It's all about **how the corneal epithelium is managed**

Photoablative Refractive Surgery

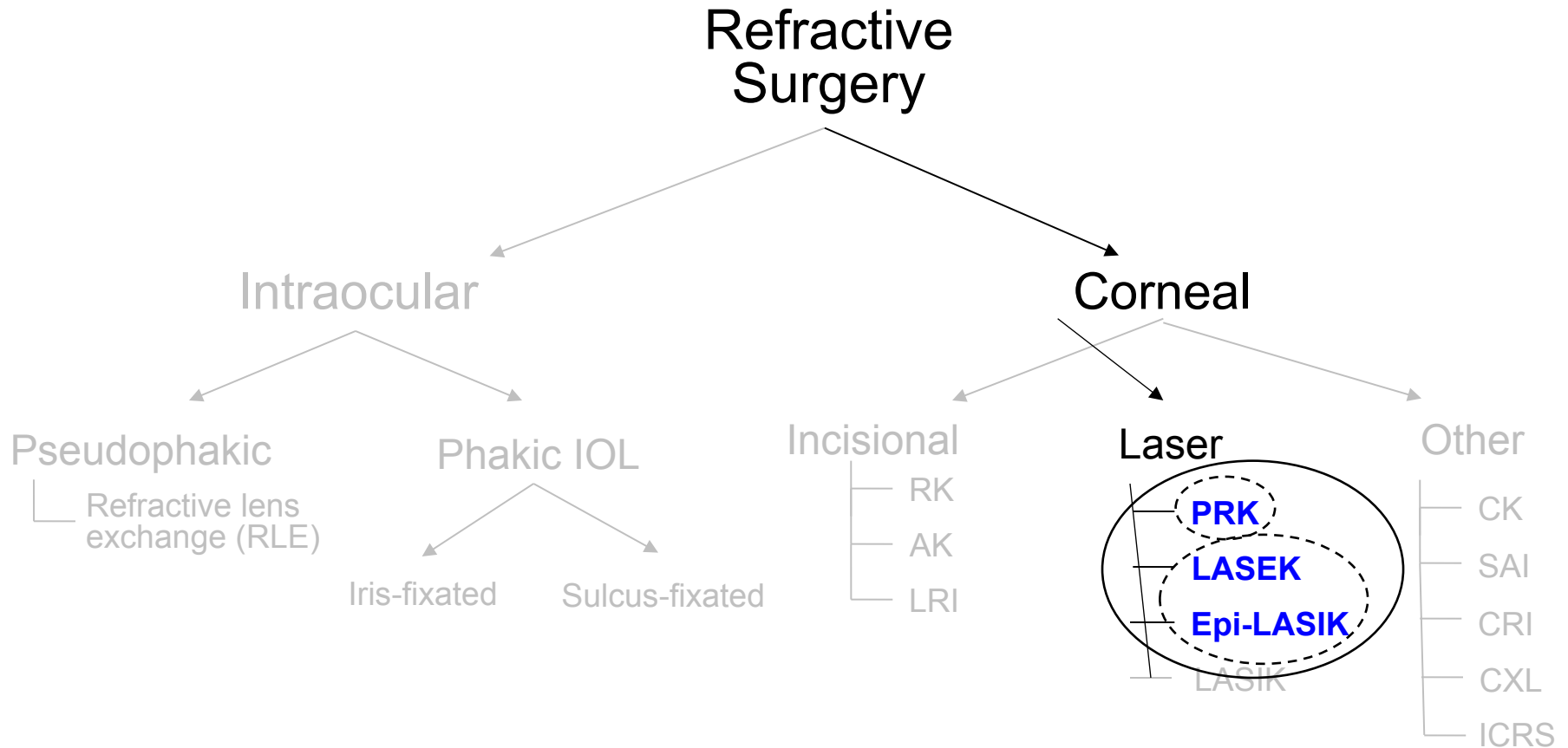


How do the surface-ablation procedures differ from one another?

It's all about **how the corneal epithelium is managed**

In which way do LASEK and epi-LASIK differ from PRK?

Photoablative Refractive Surgery



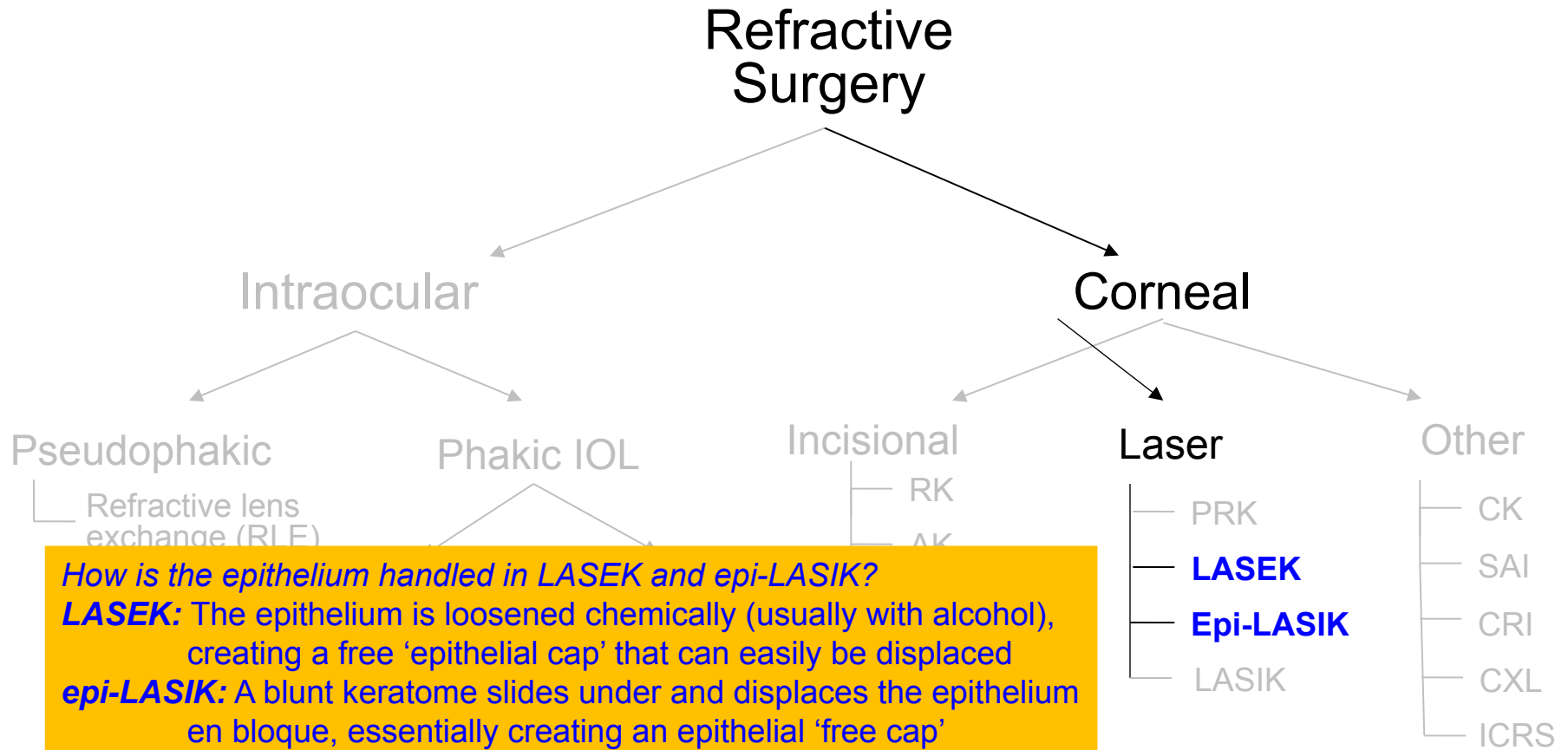
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In LASEK and epi-LASIK, an epithelial cap is created and displaced, and then re-placed after the subepithelial surface has been ablated. In **PRK**, **no attempt is made to preserve the epithelium** for re-placement after ablation—the post-ablation surface is left epithelium-free.

Photoablative Refractive Surgery



How do the surface-ablation procedures differ from one another?

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In what fundamental way do LASEK and epi-LASIK differ from PRK?

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LASEK -Laser Subepithelial Keratectomy

Hybrid between PRK and LASIK
“Flap” of epithelium



Advantages:No flap complications.

Good for patient with thin cornea.

Slightly faster recovery than PRK

Less incidence of haze than PRK

Results similar to PRK and LASIK

Causes less dry eyes than LASIK.

Finer trephine blade is used instead of microkeratome.

Disadvantages:May cause more pain and discomfort than LASIK.

Dry eyes.

Longer recovery time than LASIK.

Laser Sub-epithelial Keratomileusis(LASEK)



Metal handle as alcohol reservoir



Epithelial flap formation
With Vannas scissors



Ablation with excimer laser



Epithelial sheet is repositioned



Bandage contact lens is placed

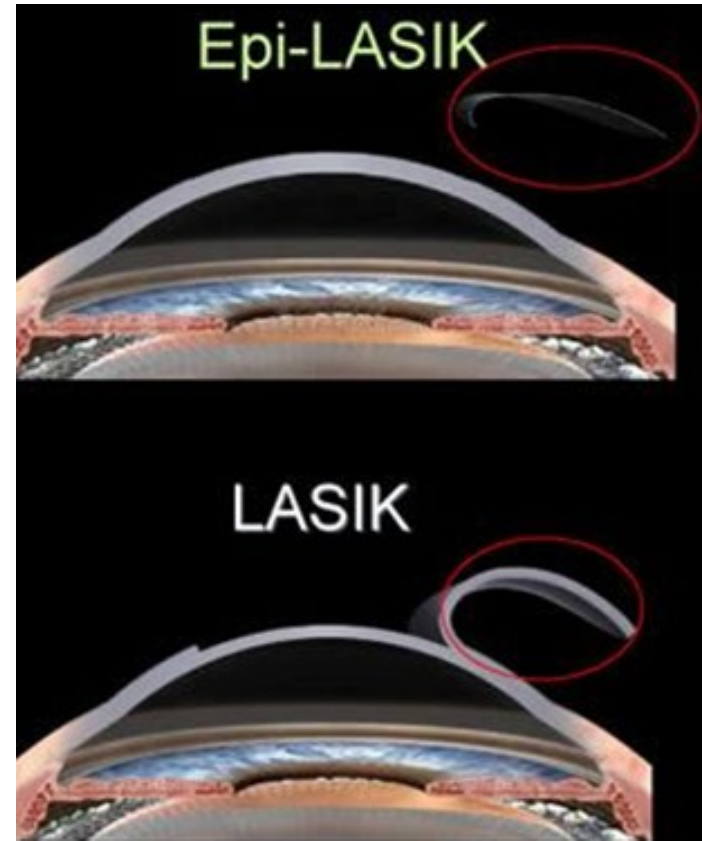
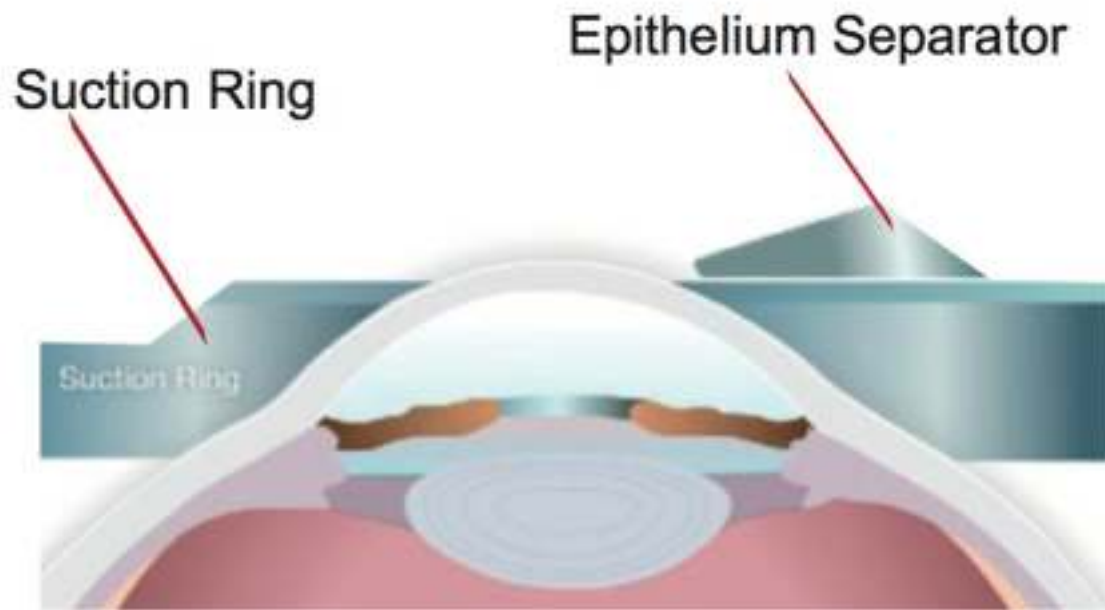
Epipolis-laser in Situ Keratomileusis (epi-LASIK)

Indication

Less steep corneas (low myopia)

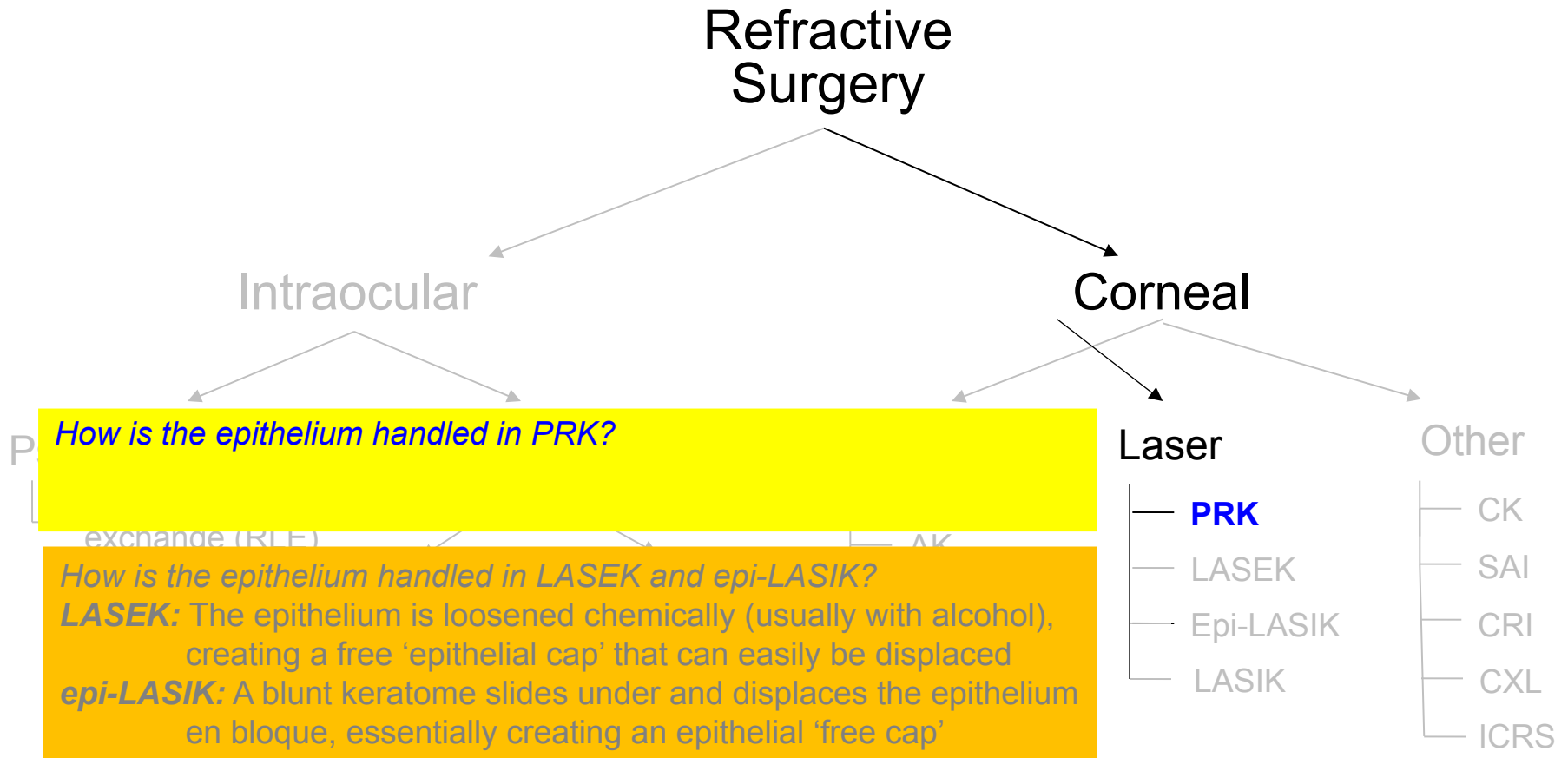
Advantage over LASEK

- Less pain
- Faster healing
- Less corneal haze



Epi-LASIK

Photoablative Refractive Surgery



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It's all about how the corneal epithelium is managed

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Photoablative Refractive Surgery

Refractive Surgery

Intraocular

Corneal

How is the epithelium handled in PRK?

It is removed via scraping, chemical destruction, brushing, etc.

Laser

Other

PRK

LASEK

Epi-LASIK

LASIK

CK

SAI

CRI

CXL

ICRS

How is the epithelium handled in LASEK and epi-LASIK?

LASEK: The epithelium is loosened chemically (usually with alcohol), creating a free 'epithelial cap' that can easily be displaced

epi-LASIK: A blunt keratome slides under and displaces the epithelium en bloque, essentially creating an epithelial 'free cap'

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Photoablative Refractive Surgery

Refractive Surgery

Intraoperatively, PRK is the simplest of the laser myopic keratorefractive procedures. However, it has two major post-operative complications that render it less than ideal:

- 1) It is associated with significant post-op word
- 2)

*How is the epithelium handled in **PRK**?*

Harshly. It is removed via scraping, chemical destruction, brushing, etc.

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Laser

- **PRK**
- LASEK
- Epi-LASIK
- LASIK

Other

- CK
- SAI
- CRI
- CXL
- ICRS

Photoablative Refractive Surgery

Refractive Surgery

PRK seems much simpler—why bother with the other procedures?

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Refractive lens
exchange (RLE)

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- 1) It is associated with significant post-op **pain**
- 2) It is associated with an increased risk of post-op

two words

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Harshly. It is removed via scraping, chemical destruction, brushing, etc.

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exchange (RLE)

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Refractive Surgery

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- 1) It is associated with significant post-op **pain**
- 2) It is associated with an increased risk of post-op **haze formation**.

*How is the epithelium handled in **PRK**?*

Harshly. It is removed via scraping, chemical destruction, brushing, etc, or just lased away.

How is the epithelium handled in LASEK and epi-LASIK?

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Laser

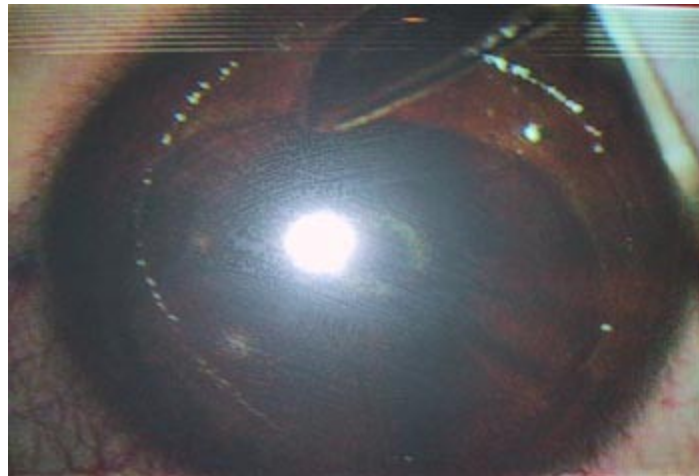
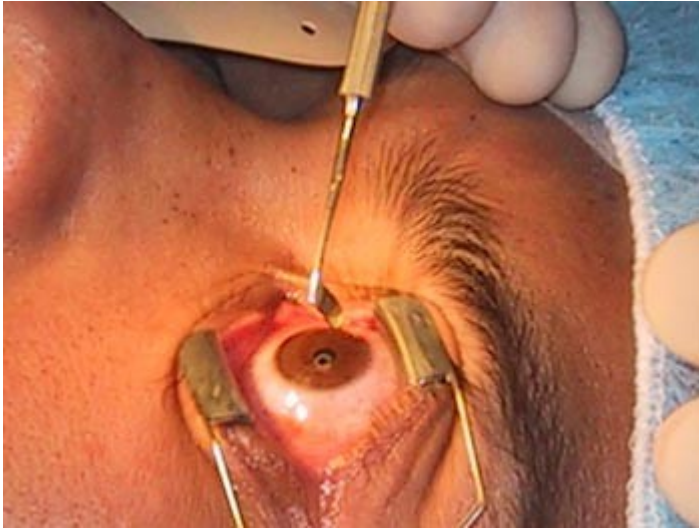
- **PRK**
- LASEK
- Epi-LASIK
- LASIK

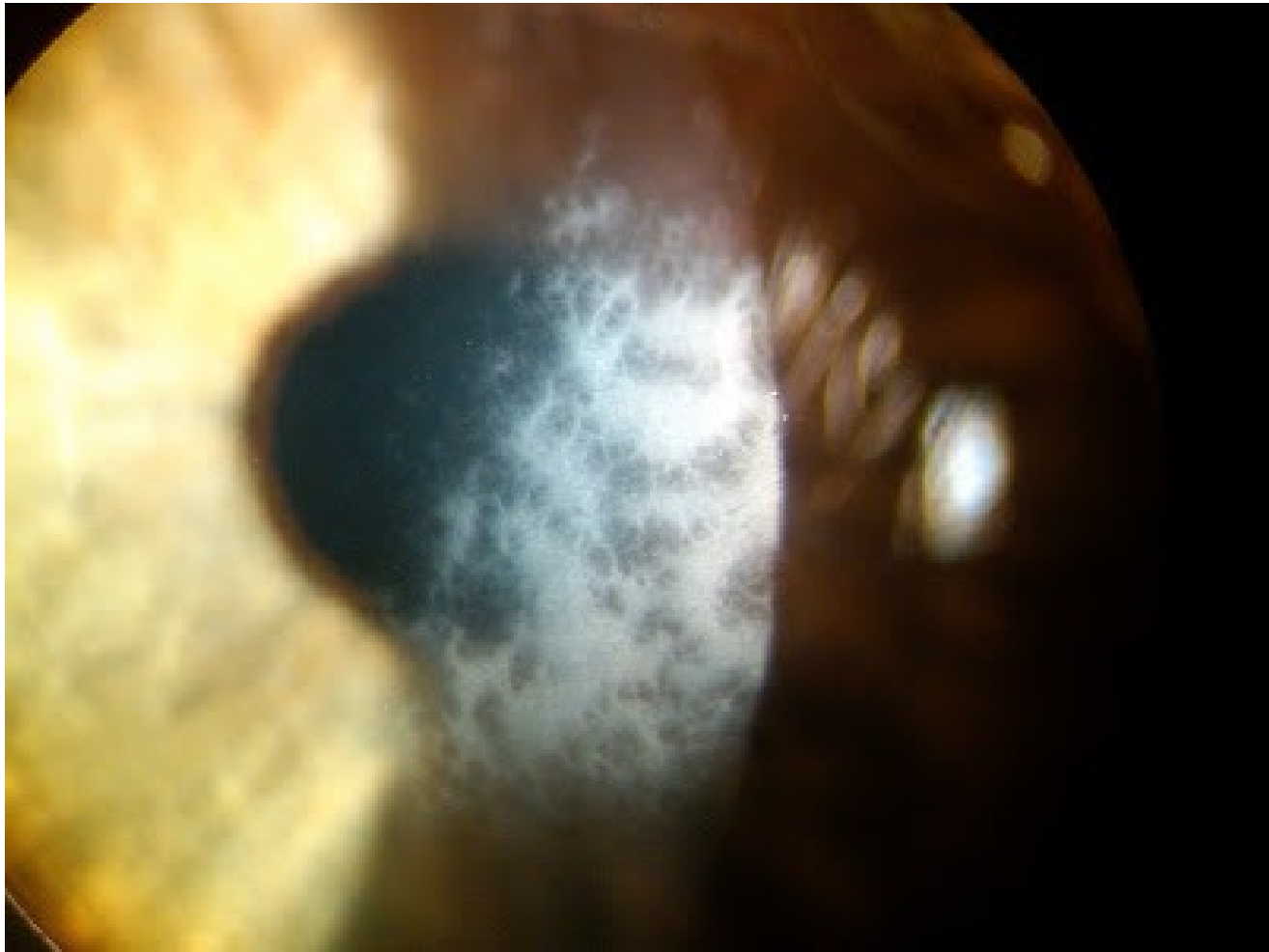
Other

- CK
- SAI
- CRI
- CXL
- ICRS

*Epithelium in **PRK***

It is removed via scraping, chemical destruction, brushing.





Post-PRK haze

Photoablative Refractive Surgery

Refractive Surgery

```
graph TD; RS[Refractive Surgery] --> PRK[PRK]; RS --> L[Laser]; RS --> O[Other]; PRK --> PL[Laser]; PRK --> PO[Other];
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- 1) It is associated with significant post-op pain
- 2) It is associated with an increased risk of post-op haze formation.

How is the epithelium handled in PRK?

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Why is PRK so painful post-operatively?

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Photoablative Refractive Surgery

Refractive Surgery

```
graph TD; RS[Refractive Surgery] --> PRK[PRK]; RS --> Laser[Laser]; RS --> Other[Other]; PRK --> Laser; PRK --> Other;
```

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en bloque, essentially creating an epithelial tree cap

How do the surface-ablation procedures differ from one another?

It's all about how the corneal epithelium is managed

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Mitomycin C, a chemotherapeutic agent

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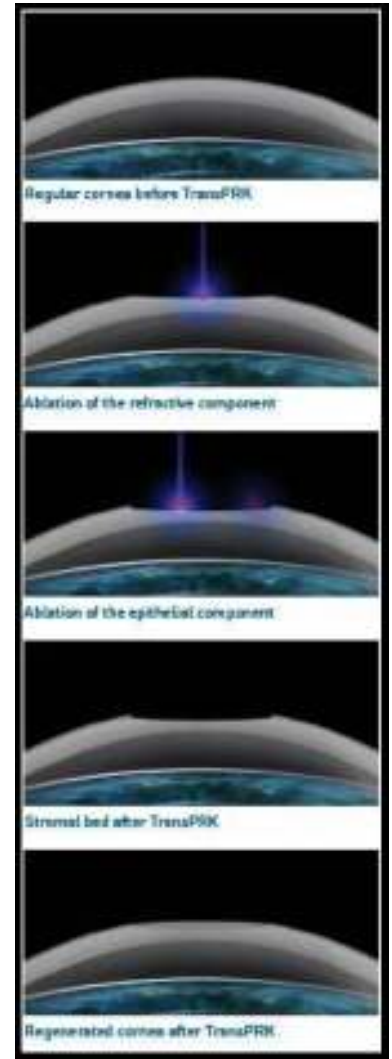
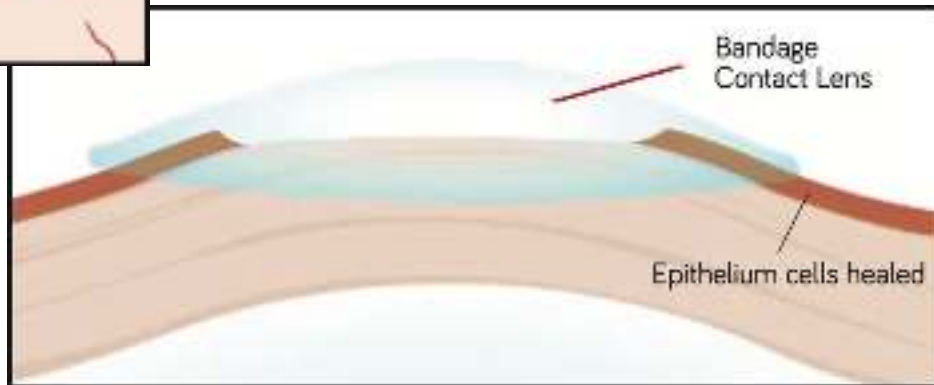
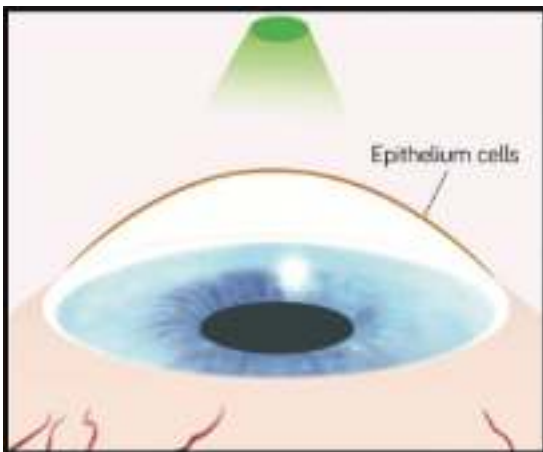
Laser

Other

SCHWIND TransPRK – Touch-free eye laser treatment

- With TransPRK the eye is not touched with any instrument.
- The laser removes the epithelium, without suction, flap, or blade, and without the use of alcohol.
- This touch-free procedure is non-invasive, safe, and gentle to the eye.

Transepithelial PRK No-touch technique



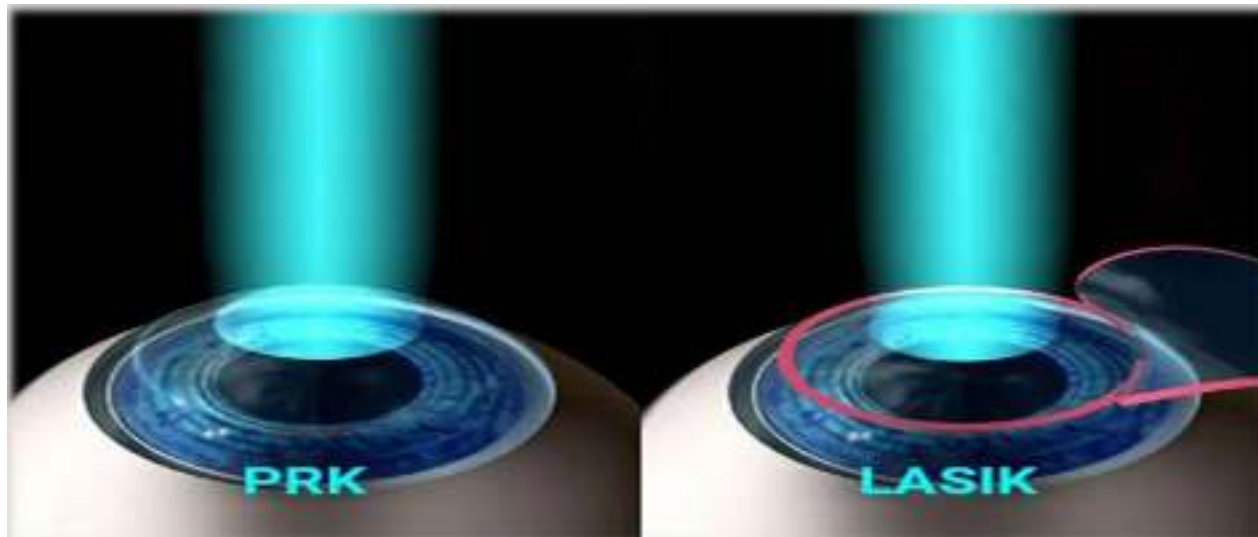
Comparison to PRK

Studies indicate that one-step trans-PRK provides:

- faster epithelial healing
- lower pain scores
- significantly less haze formation in comparison with PRK with epithelial removal.⁷
- Trans-PRK is faster to perform
- Is an all-laser procedure, unlike PRK where the epithelium is manually removed.
- Patients like to know that it is a truly all-laser procedure, and this is a great marketing tool.

7. Kaluzny BJ, Cieslinska I, Mosquera SA, Verma S. Single-step transepithelial PRK vs alcohol-assisted PRK in myopia and compound myopic astigmatism correction. *Medicine (Baltimore)*. 2016 ;95(6):e1993.

LASIK Vs PRK



LASIK Pros

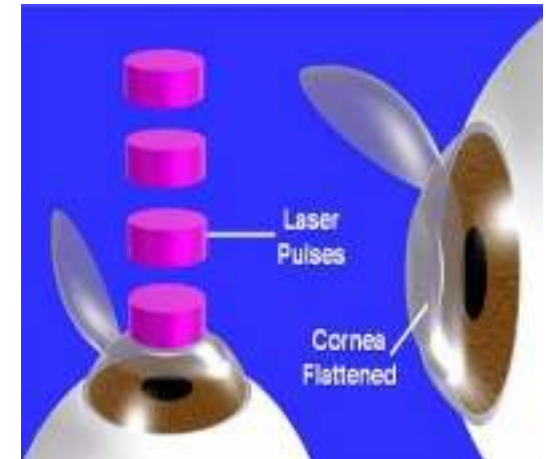
- **Recovery Time:** Only the edges of the flap that need to heal. Therefore **LASIK patients spend less time in recovery**, often returning to their normal routines within a day or two.
- **Safety and Comfort:** Less disruption of the cornea allows LASIK to be performed **in a shorter amount of time** and with less post-operative discomfort.
- **Treatment Options:** Myopia-Hyperopia-Astigmatism

CUSTOMIZED ABLATIONS

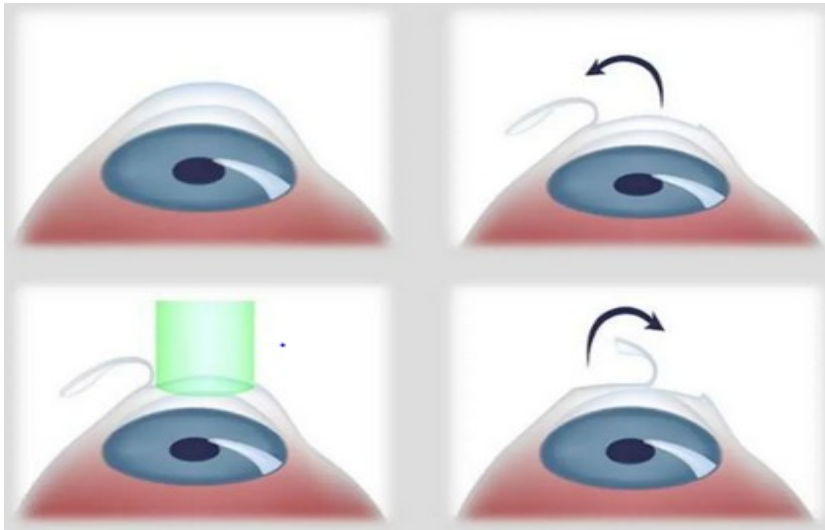
- **Safety and Comfort:** Patients may experience **some irritation and discomfort** for up to 24 hours after surgery. This is minor and is generally managed with lubricating eye drops.

LASIK (Laser-assisted in situ keratomileusis)

- 01** Most commonly performed refractive surgery
- 02** Excimer laser ablation of corneal stroma beneath a corneal flap that is created with a **mechanical** or **femtosecond laser microkeratome**



LASIK (Laser-assisted in situ keratomileusis)



Steps of LASIK

- ✓ Flap creation
- ✓ Apply excimer laser
- ✓ Flap returned

BASIC STEPS AND MACHINE SPECIFICATIONS

- Topical anesthesia-Proparacaine 0.5%, Lidocaine 4%.
- Surgical Painting and draping(Lint Free).
- Lid speculum with aspiration.
- Corneal marking-Orientation of free cap

Creation of flap

- 1st Step-Creation of suction by suction pump to raise the IOP to 65 mm Hg which is necessary for the microkeratome to create a pass and resect the corneal flap.
- This is crosschecked with Barraquers tonometer.

2nd step-Resection of corneal flap

Microkeratome -Femtosecond Laser



Technique:

The suction ring is centered over the pupil.

The docking procedure is then initiated while keeping the suction ring parallel to the eye.

- Microkeratome- Uses Disposable blades.
- Blade Plate can be set at 120 μ ,140 μ ,160 μ and180 μ .
- Nasal or superiorly hinge flaps can be created. Eg.Hansatome,ACS,Carriazo Barraquer, Moria.
- Femtosecond Laser for Flap-
- Creates photodisruption using femtosecond solid state laser with wavelength of 1053nm.
- Needs lower vacuum.
- Very short pulse with spot size of 3 μ -High precision cutting device.
- Any hinge can be made
- Can make flaps as thin as 100 μ (Sub Bowmanns Keratomileusis)
- Flap has vertical edges –so reduced epithelial ingrowth.
- Microkeratome flap thicker in periphery and thinner in the centre.
- Not so with Femtosecond Laser (Planar)



3rd Step-Delivery of Laser-

After flap is lifted, laser is applied to the stroma according to the ablation profile calculated by the machine.

Laser beam is delivered by the following ways depending on the machine- Beam Delivery Broad Beam Scanning Slit Beam Flying Spot

- Most machines employ a **flying spot** to deliver laser with the help of incorporated eye tracker

4th step-Reposition Of the Flap-

- After irrigating interface ,flap repositioned
- Adhesion test-Striae test

COMPLICATIONS



Epithelial
ingrowth



Diffuse intralamellar
keratitis



Flap striae



Epithelial defect



Button hole



Free cap



Incomplete flap



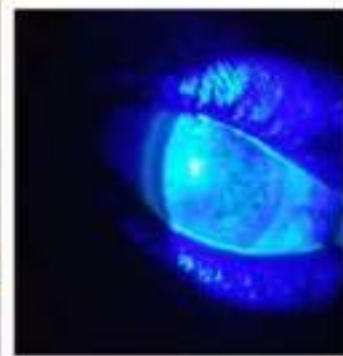
Dislodged flap



Halos



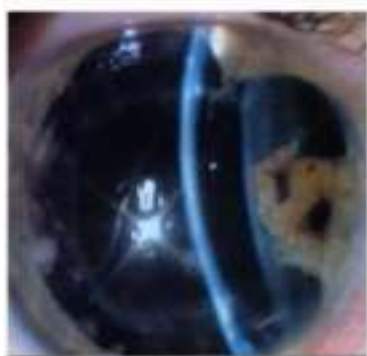
Glare



Dry eye



Bacterial keratitis



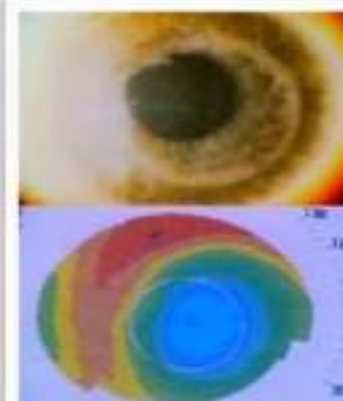
Perforated cornea



Non healing flap



Loose epithelium



Decentered flap & ablation

Iatrogenic Keractasia

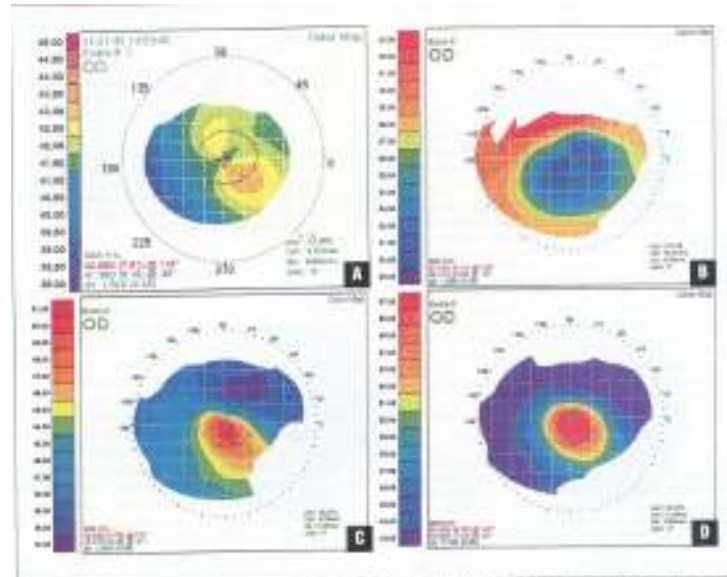
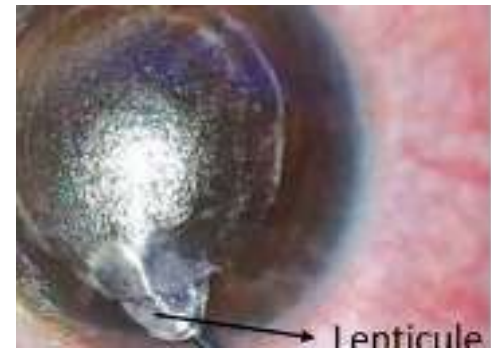


Figure 3: Baseline and postoperative videokeratograms of patient 3. Preoperatively (A) and 20 days after LASIK (B), no signs of keratoconus were present. Right months later surgery (C) central steepening had occurred that showed progression during the following 2 months (D).

- JRS Vol. 14 May/June 1998, Seiler, Koufala.

NEVER LASIK ON CORNEA $< 500\mu$
RESIDUAL STROMA AFTER ABLATION 300μ
NEVER perform LASIK on KC suspects

SMILE



- Small-incision lenticule extraction (SMILE).
- In SMILE procedure, a corneal flap is not created.
- A small incision is made in the mid-periphery of the cornea with the laser, and the lenticule is removed through this self-sealing incision.
- The SMILE procedure has additional potential advantages.
- No corneal flap is created, SMILE may pose less risk for post-surgical dry eye and ectasia than LASIK.
- No risk of flap displacement from trauma to the eye after surgery

Refractive surgeries

Preoperative assessment (History)



Corneal ectasia (KC)



Refractive surgeries

Preoperative assessment (History)



Why age is important ?

- Under 20 years have higher chances of being unstable
- over 45 years have following drawbacks:
 - 01- Is the age of presbyopia.
 - 02- Many of them will develop lenticular changes (Cataract).

Refractive surgeries

Preoperative assessment (stabilization of refraction)



- The procedures should be done only on eyes that have unchanged errors of refraction, at least 1 year prior to surgery.

Refractive surgeries

Preoperative assessment (Contraindications)

Absolute C/I

- | | |
|----|-----------------------------|
| 01 | Infection |
| 02 | Keratoconus |
| 03 | Glaucoma |
| 04 | Posterior segment anomalies |
| 05 | Immune suppression |
| 06 | Corneal dystrophies |
| 07 | Amblyopia |

Relative C/I

- | | |
|----|-------------------------------|
| 01 | Dry eyes |
| 02 | Allergic keratoconjunctivitis |
| 03 | Diabetes mellitus |
| 04 | Pregnancy |

Summary

- The journey of refractive surgery has evolved from corneal incisional surgeries to excimer – laser based corneal ablative procedures to present day minimally invasive femtosecond laser- based techniques such as SMILE.
- Every procedure has its own advantages and disadvantages , and the pros and cons must be weighted on an individual basis.
- Pre- operative work up is essential for a successful refractive practice.

Summary

- Patients should be made aware about the choice of procedure suited for them along with possible visual outcomes and complications.
- Laser-assisted in situ keratomileusis is the most commonly performed refractive surgery worldwide.
- SMILE has similar efficacy, predictability, and safety as femtosecond-LASIK.



Thank you for your attention!