Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because *some* aspect of the pt’s post-op visual life will be less than ideal, key to successful refractive surgery is 1) developing a solid understanding of the pt’s visual preferences and requirements, and 2) communicating effectively with the pt regarding what her post-op visual life will be; ie, establishing expectations that are realistic and achievable.

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because *some* aspect of the pt's post-op visual life will be less than ideal, key to successful refractive surgery is 1) developing a solid understanding of the pt's visual preferences and requirements, and 2) communicating effectively with the pt regarding what her post-op visual life will be; ie, establishing expectations that are realistic and achievable. Further, the surgeon must have a refined eye (ahem) for recognizing pre-existing ocular conditions that render the pt a poor surgical candidate (or increase the risk of complications down the road).

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because *some* aspect of the pt's post-op visual life will be less than ideal, key to successful refractive surgery is 1) developing a solid understanding of the pt's visual preferences and requirements, and 2) communicating effectively with the pt regarding what her post-op visual life will be; ie, establishing expectations that are realistic and achievable. Further, the surgeon must have a refined eye (ahem) for recognizing pre-existing ocular conditions that render the pt a poor surgical candidate (or increase the risk of complications down the road).

Just as the goal of refractive surgery is simple, so too is its organization. Broadly speaking, there are but two types of surgery: **Corneal** and **intraocular**.

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because *some* aspect of the pt's post-op visual life will be less than ideal, key to successful refractive surgery is 1) developing a solid understanding of the pt's visual preferences and requirements, and 2) communicating effectively with the pt regarding what her post-op visual life will be; ie, establishing expectations that are realistic and achievable. Further, the surgeon must have a refined eye (ahem) for recognizing pre-existing ocular conditions that render the pt a poor surgical candidate (or increase the risk of complications down the road).

Just as the goal of refractive surgery is simple, so too is its organization. Broadly speaking, there are but two types of surgery: **Corneal** and **intraocular**. Corneal (aka *keratorefractive*) procedures work by reshaping the cornea to offset the native refractive error of the eye; there are a plethora of techniques and technologies for doing this.

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because *some* aspect of the pt's post-op visual life will be less than ideal, key to successful refractive surgery is 1) developing a solid understanding of the pt's visual preferences and requirements, and 2) communicating effectively with the pt regarding what her post-op visual life will be; ie, establishing expectations that are realistic and achievable. Further, the surgeon must have a refined eye (ahem) for recognizing pre-existing ocular conditions that render the pt a poor surgical candidate (or increase the risk of complications down the road).

Just as the goal of refractive surgery is simple, so too is its organization. Broadly speaking, there are but two types of surgery: **Corneal** and **intraocular**. Corneal (aka *keratorefractive*) procedures work by reshaping the cornea to offset the native refractive error of the eye; there are a plethora of techniques and technologies for doing this. In contrast, *intraocular procedures* are more limited in their variety: They involve either replacing the native lens with an IOL, or placing in the anterior chamber an accessory IOL that offsets the eye's native refractive error.

Refractive Surgery Overview

The goal of refractive surgery is deceptively straightforward and simple: To render the pt less reliant upon refractive accoutrements (ie, contacts and glasses). Ideally, a pt s/p refractive surgery would have 20/20 vision at *all* distances, under *any* lighting conditions, with *no* dysphotopsias (visual experiences that degrade vision quality), and with *no* risk of future negative repercussions vis a vis the long-term health and/or optical performance of the eye. Also ideally, the above could be achieved irrespective of pre-op refractive status and/or pre-existing ocular conditions.

Current technology is unable to meet this lofty ideal, and thus refractive surgery necessitates compromises and trade-offs; eg, If you *had* to pick one, would you rather be spectacle-free at distance, or near? Would it be acceptable if you only needed glasses in dimly-lit restaurants? How bothersome would haloes around lights at night be? Because some aspect of the pt's post-op visual li… underst… …ively with the… …e realistic… …g pre-existing… …f complications down the road).

***Before delving into specific surgical techniques, let's touch briefly on the optics of refractive error, starting with an overview of* vergence**

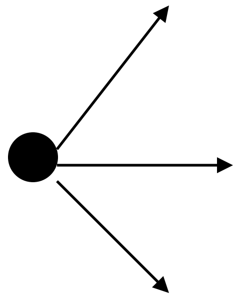
Just as the goal of refractive surgery is simple, so too is its organization. Broadly speaking, there are but two types of surgery: **Corneal** and **intraocular**. Corneal (aka *keratorefractive*) procedures work by reshaping the cornea to offset the native refractive error of the eye; there are a plethora of techniques and technologies for doing this. In contrast, *intraocular procedures* are more limited in their variety: They involve either replacing the native lens with an IOL, or placing in the anterior chamber an accessory IOL that offsets the eye's native refractive error.

Refractive Surgery Overview

- The term *vergence* describes what light rays are doing in relation to each other

Refractive Surgery Overview

- The term *vergence* describes what light rays are doing in relation to each other
- With respect to a given point, light rays can:
  - spread out (**diverge**)

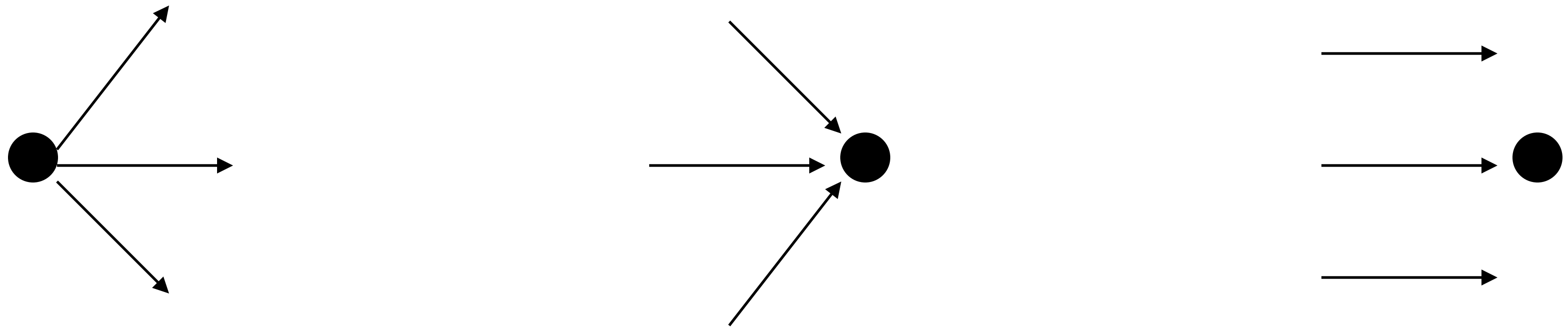


Refractive Surgery Overview

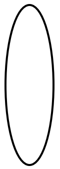
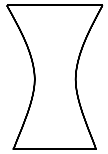
- The term *vergence* describes what light rays are doing in relation to each other
- With respect to a given point, light rays can:
  - spread out (**diverge**)
  - come together (**converge**)

Refractive Surgery Overview

- The term *vergence* describes what light rays are doing in relation to each other
- With respect to a given point, light rays can:
  - spread out (**diverge**)
  - come together (**converge**)
  - run parallel (**vergence = zero**)

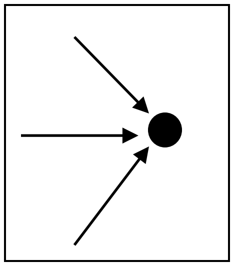


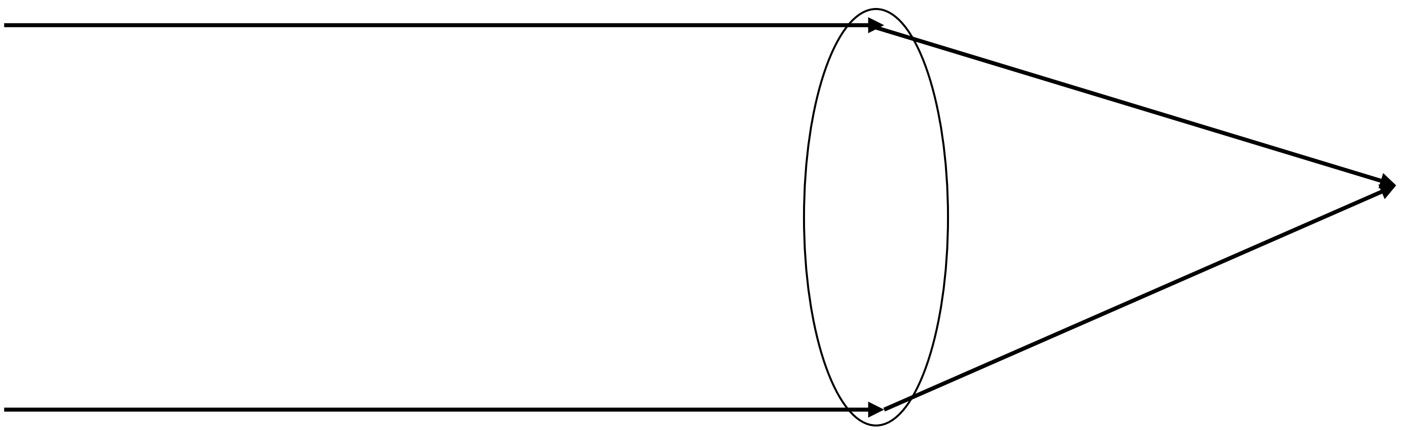
Refractive Surgery Overview

- Two basic types of spherical lenses
  - Plus 
  - Minus 

Refractive Surgery Overview

- *Plus* lens: induces convergence

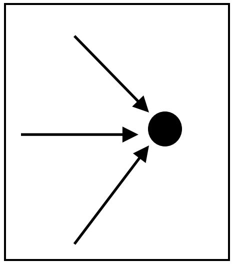




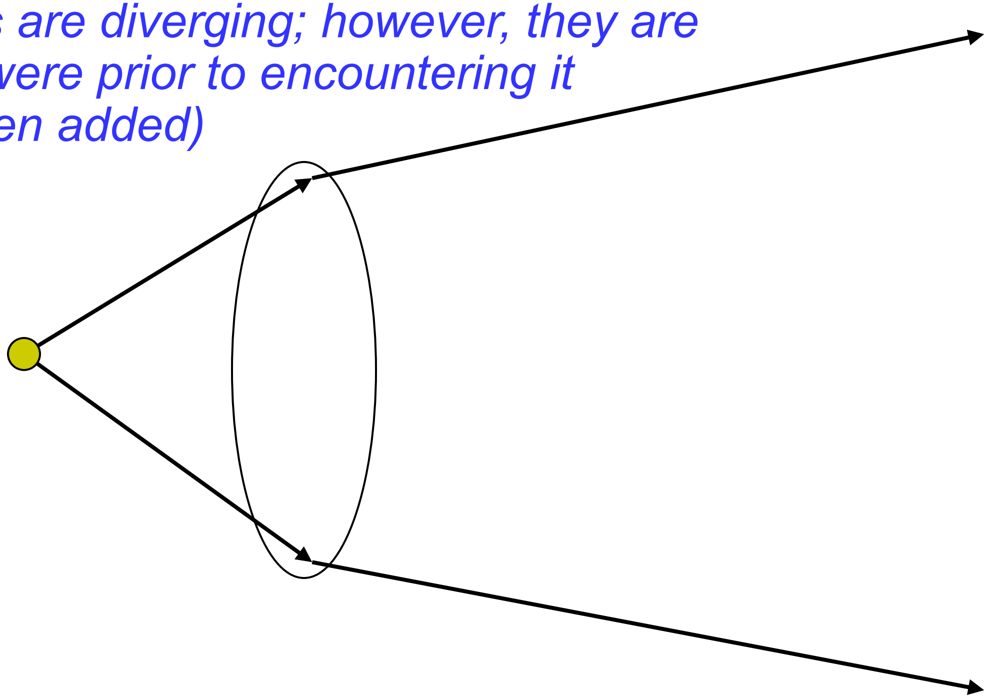
In this example, a plus lens causes previously parallel rays to converge to a point

Refractive Surgery Overview

- *Plus* lens: induces convergence

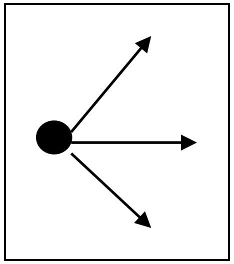


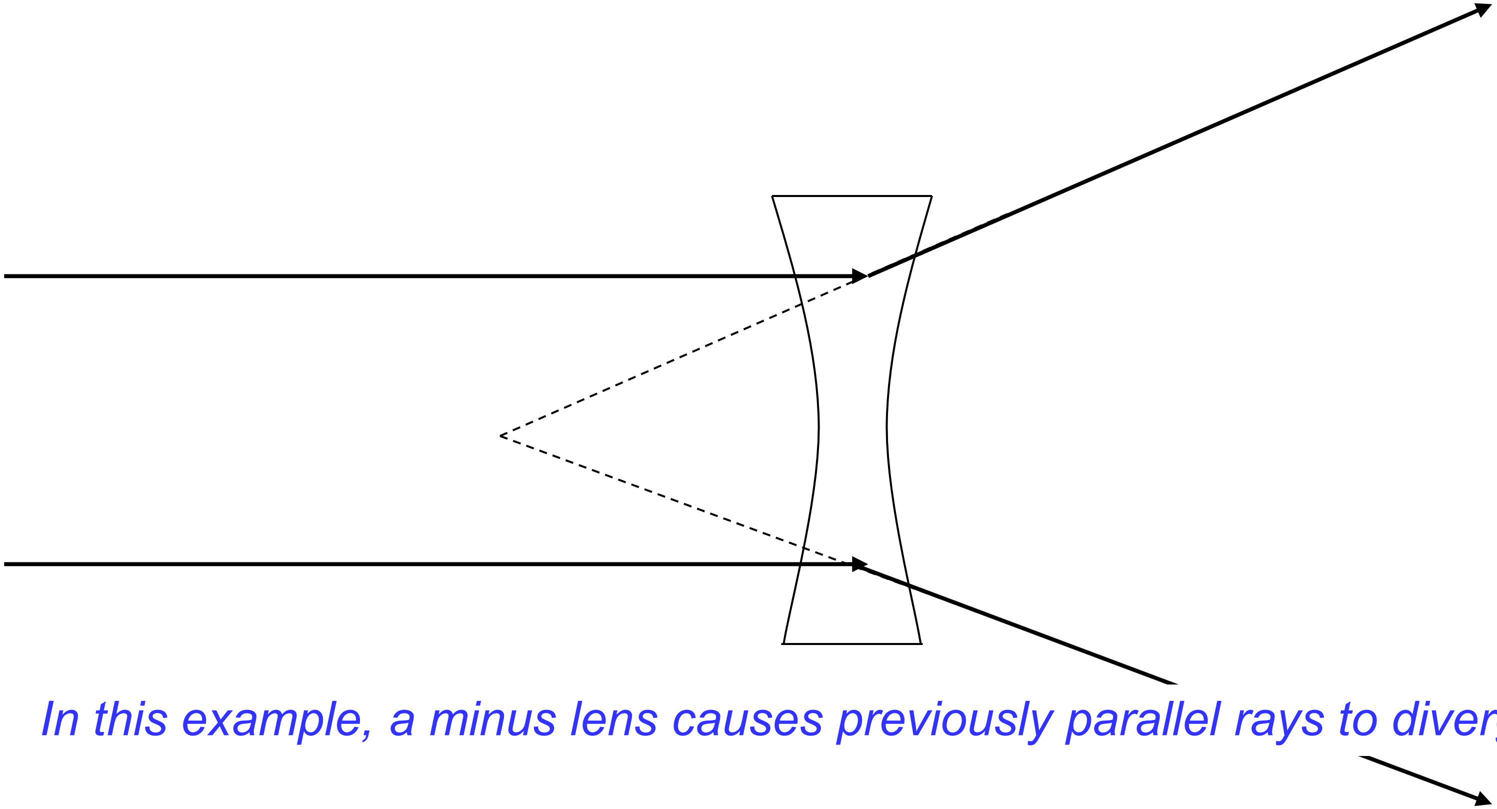
Rays exiting this plus lens are diverging; however, they are ***less*** *divergent than they were prior to encountering it (i.e., convergence has been added)*



Refractive Surgery Overview

- *Minus* lens: induces divergence

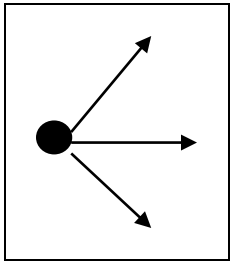




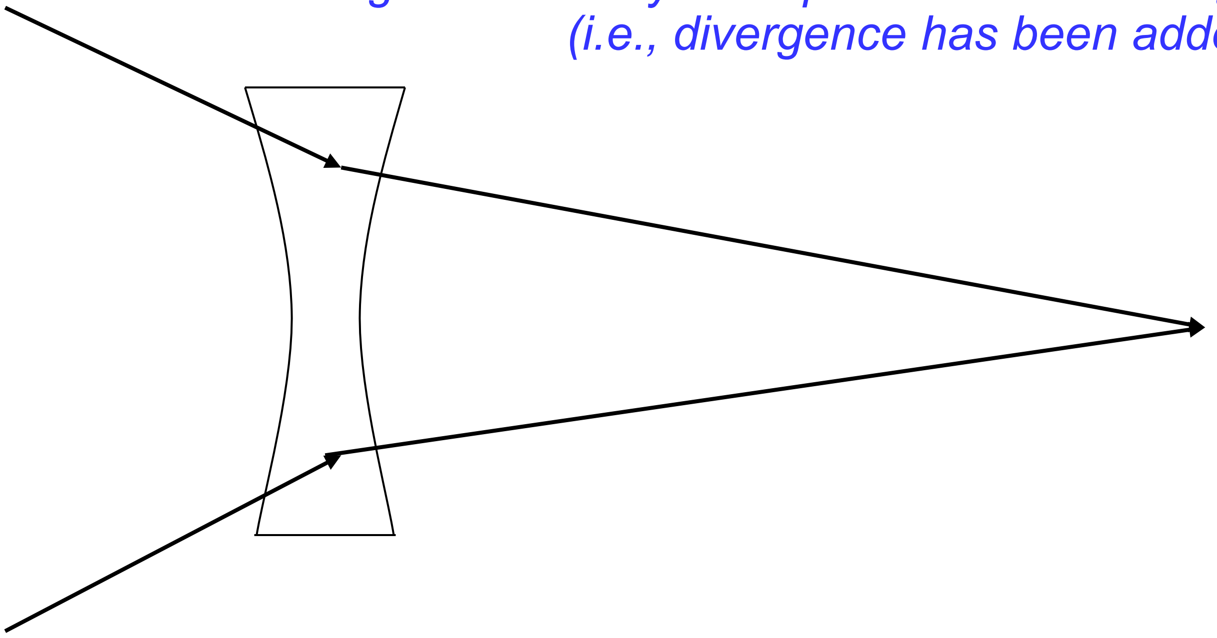
In this example, a minus lens causes previously parallel rays to diverge from a point

Refractive Surgery Overview

- *Minus* lens: induces divergence



Rays exiting this minus lens are converging; however, they are **less** *convergent than they were prior to encountering it (i.e., divergence has been added)*



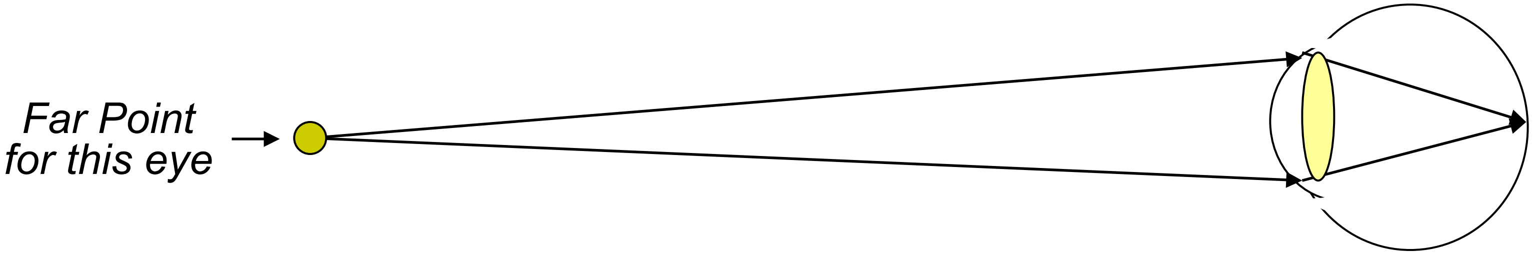
Refractive Surgery Overview

- The refractive state of an eye—that is, whether it is emmetropic, myopic or hyperopic—is determined by the location of its ***far point***

Refractive Surgery Overview

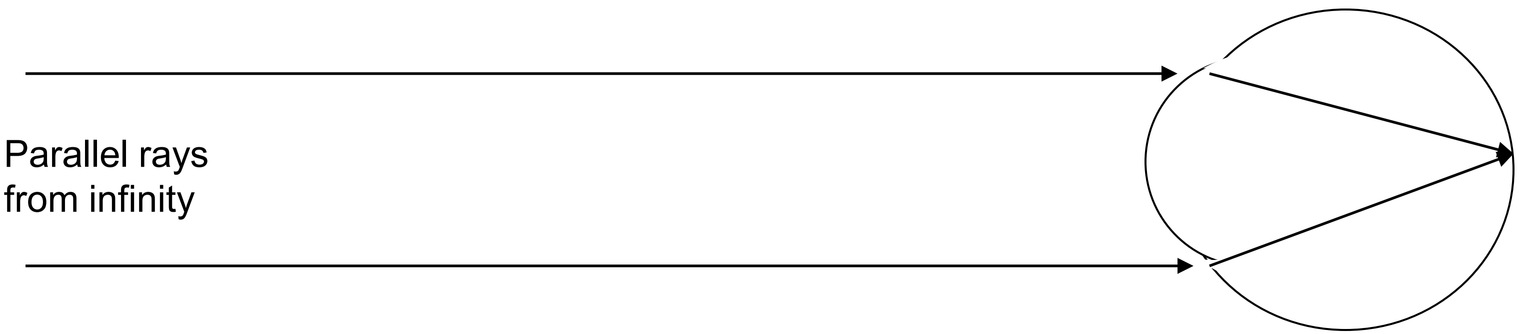
- The refractive state of an eye—that is, whether it is emmetropic, myopic or hyperopic—is determined by the location of its ***far point***
- The far point is *the location in space from which rays will be focused on the retina when the eye is not accommodating*

(*Accommodation* refers to conformational changes in the ciliary body/lens to facilitate vision at near.)



Refractive Surgery Overview

The Emmetropic Eye



In the **emmetropic** eye, the parallel rays from a location at infinity are focused to a point located precisely on the retina.

Refractive Surgery Overview

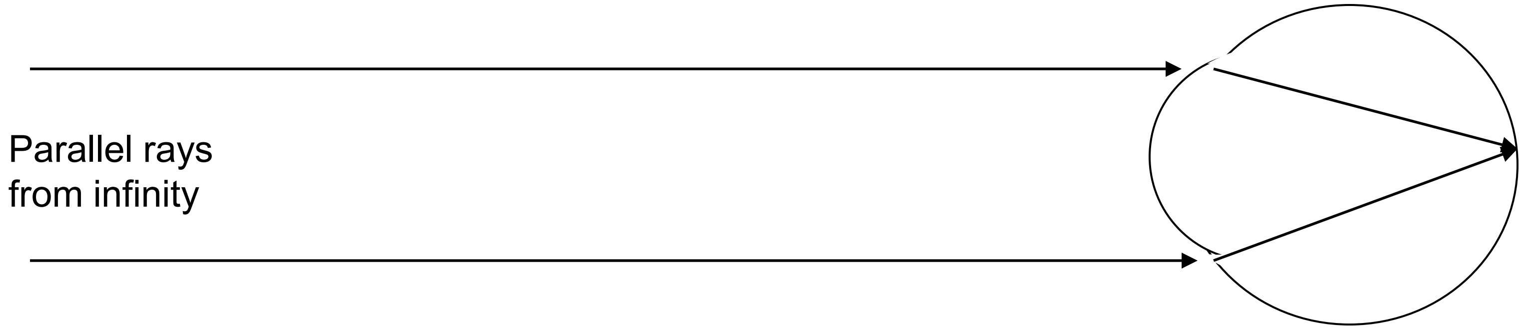
The Emmetropic Eye

In the **emmetropic** eye, the parallel rays from a location at infinity are focused to a point located precisely on the retina. In other words, *the far point of the emmetropic eye is at infinity.*

Far Point of the emmetropic eye: Infinity

Refractive Surgery Overview

The Emmetropic Eye

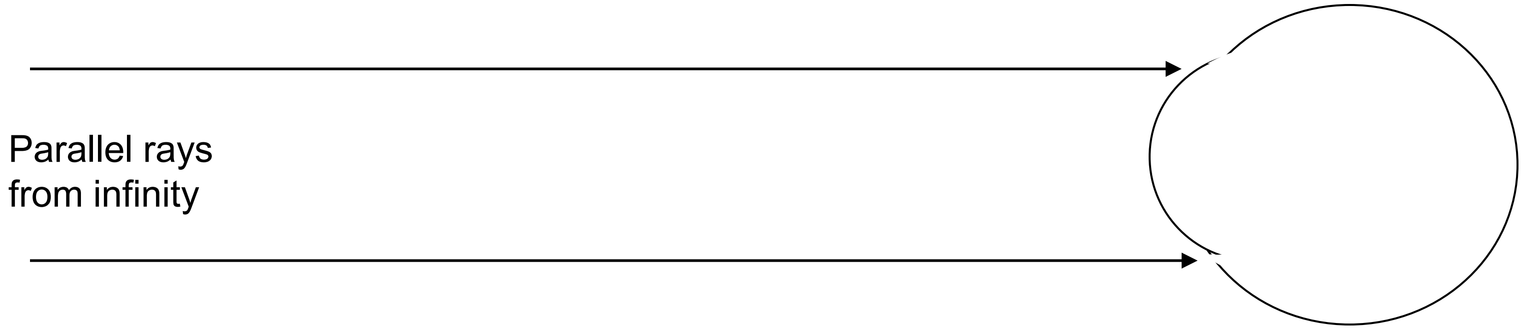


In the **emmetropic** eye, the parallel rays from a location at infinity are focused to a point located precisely on the retina. In other words, *the far point of the emmetropic eye is at infinity.* Thus, emmetropes see 20/20 (or better) at distance without correction.

Far Point of the emmetropic eye: Infinity

Refractive Surgery Overview

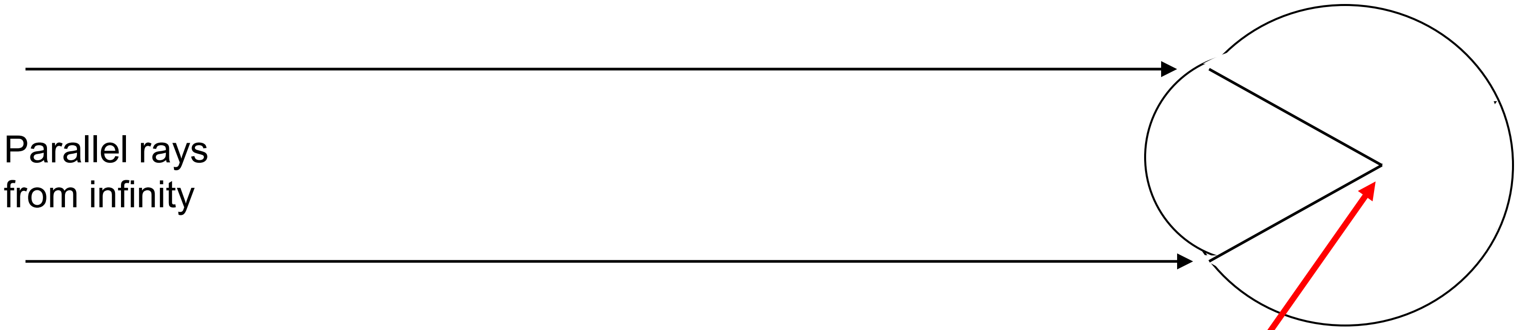
The Myopic Eye



In contrast to the sharp uncorrected distance vision of the emmetrope, consider the plight of the **myope**.

Refractive Surgery Overview

The Myopic Eye

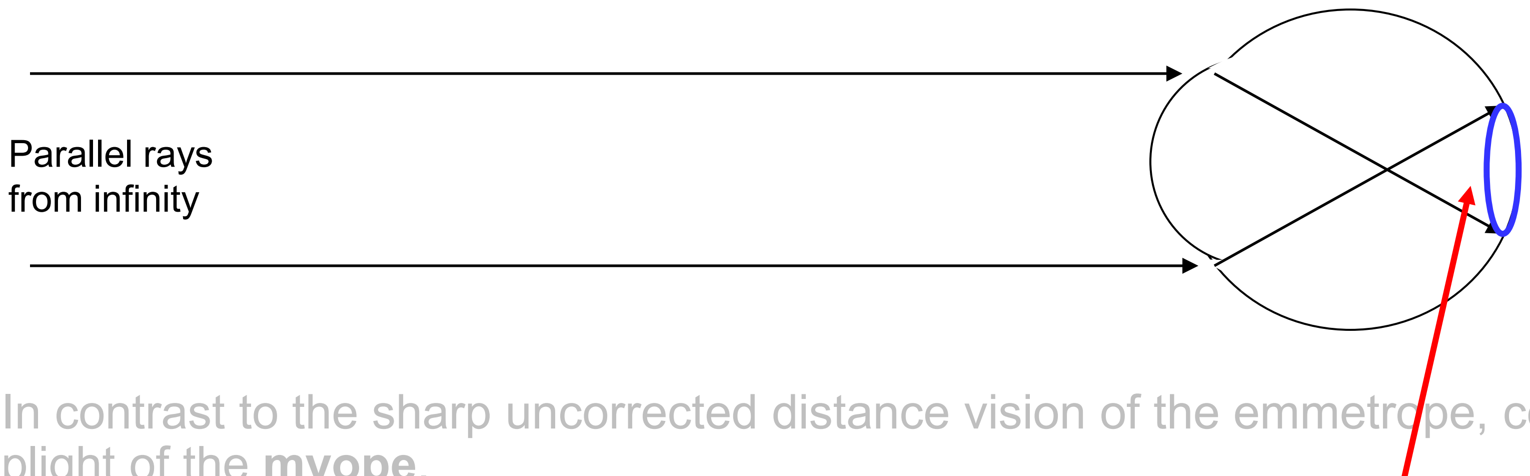


In contrast to the sharp uncorrected distance vision of the emmetrope, consider the plight of the **myope**.

In the myopic eye, rays from infinity meet in the vitreous.

Refractive Surgery Overview

The Myopic Eye



In contrast to the sharp uncorrected distance vision of the emmetrope, consider the plight of the **myope**.

In the myopic eye, rays from infinity meet in the vitreous. By the time they reach the retina, the rays have diverged to form a blur circle, not a focal point.

Refractive Surgery Overview

The Myopic Eye

The myopic eye has too much converging power for its length

In contrast to the sharp uncorrected distance vision of the emmetrope, consider the plight of the **myope**.

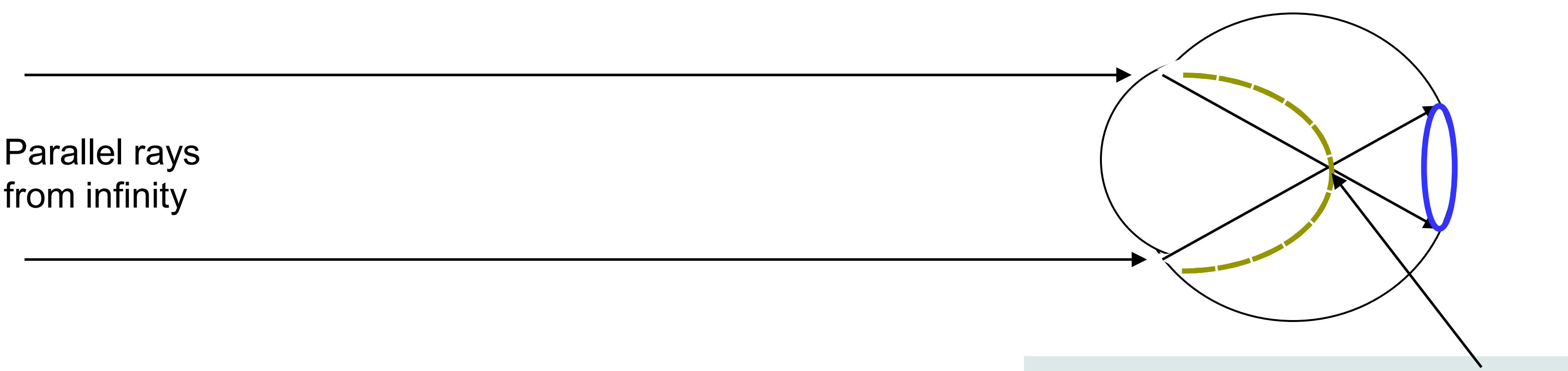
In the myopic eye, rays from infinity meet in the vitreous. By the time they reach the retina, the rays have diverged to form a blur circle, not a focal point.

You could say the myopic eye has too much converging power for its length.

Refractive Surgery Overview

The Myopic Eye

The myopic eye has too much converging power for its length



Note that if the retina was *here*, the rays from infinity would be focused to a point.

In contrast to the sharp uncorrected distance vision … er the plight of the **myope**.
In the myopic eye, rays from infinity meet in the vitreous. By the time they reach the retina, the rays have diverged to form a blur circle, not a focal point.
You could say the myopic eye has too much converging power for its length.

Refractive Surgery Overview

The Myopic Eye

The myopic eye has too much converging power for its length

In contrast to the sharp uncorrected distance vision of the emmetrope, consider the plight of the **myope**.

In the myopic eye, rays from infinity meet in the vitreous. By the time they reach the retina, the rays have diverged to form a blur circle, not a focal point.

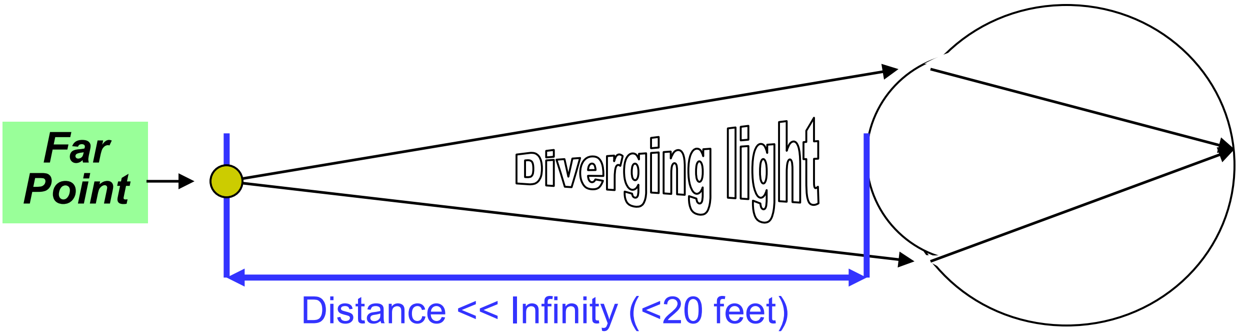
You could say the myopic eye has too much converging power for its length.

To be focused on the retina, the Far Point of a myopic eye will have to offset its excess convergence with an equivalent amount of divergence. **To accomplish this…**

Refractive Surgery Overview

The Myopic Eye

The myopic eye has too much converging power for its length

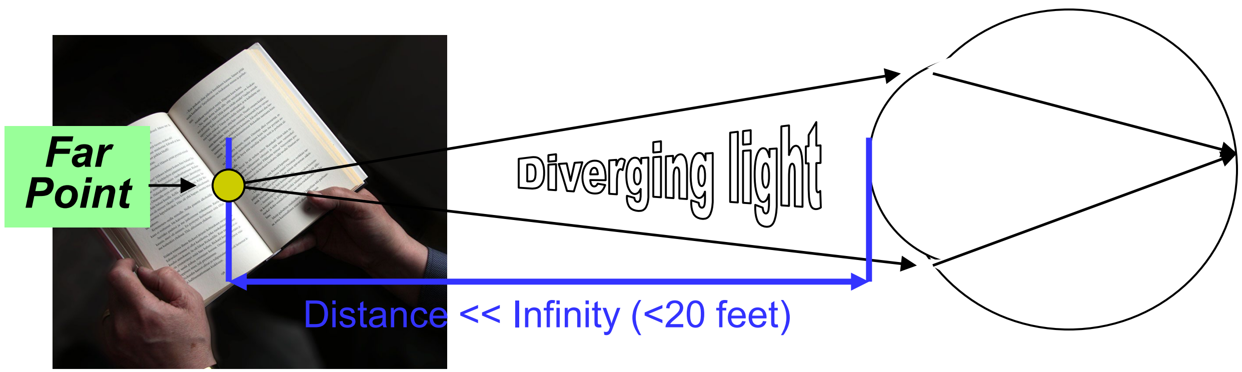


…the Far Point of a myopic eye is just anterior to the corneal plane. Rays from this location are still quite divergent when they reach the eye, and this divergence offsets the excess convergence that is built into the myopic eye. Thus, rays originating from the far point end up sharply focused at the retina.

Refractive Surgery Overview

The Myopic Eye

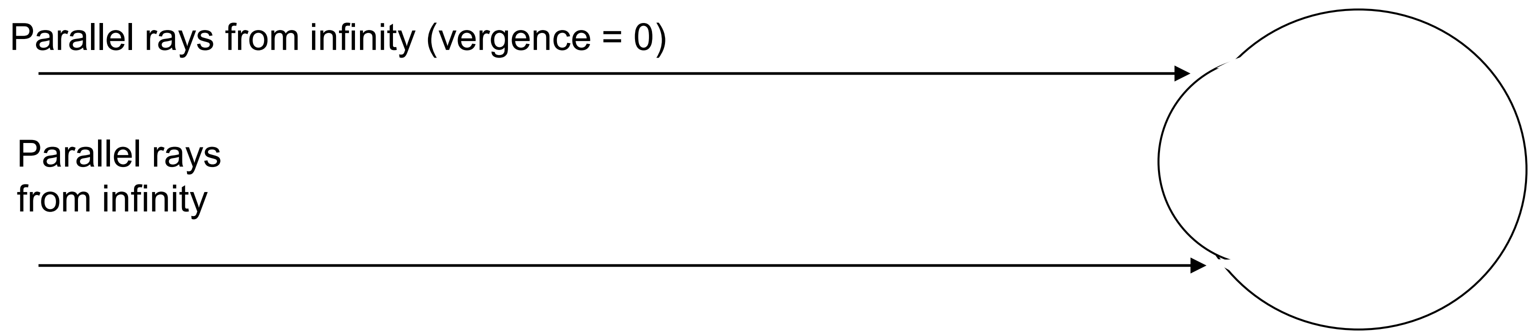
The myopic eye has too much converging power for its length



…the Far Point of a myopic eye is just anterior to the corneal plane. Rays from this location are still quite divergent when they reach the eye, and this divergence offsets the excess convergence that is built into the myopic eye. Thus, rays originating from the far point end up sharply focused at the retina. This is why nearsighted individuals can read without glasses—they're able to put the material at or near their far point.

Refractive Surgery Overview

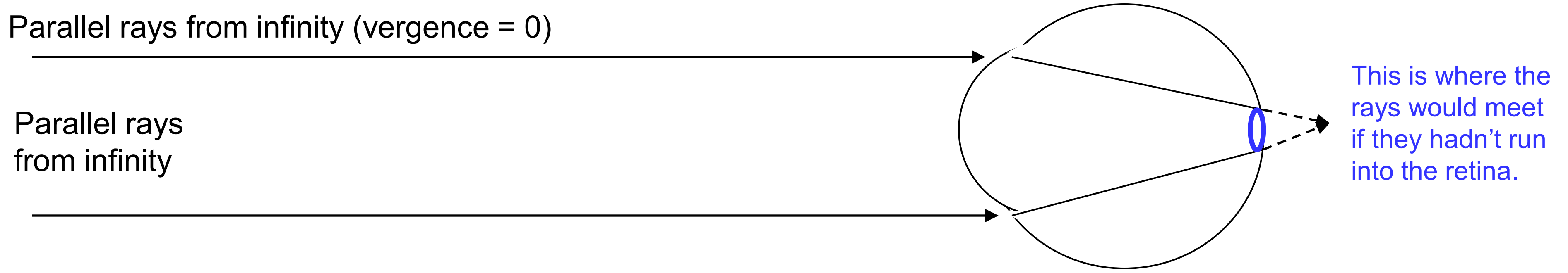
The Hyperopic Eye



Now consider the **hyperope**.

Refractive Surgery Overview

The Hyperopic Eye

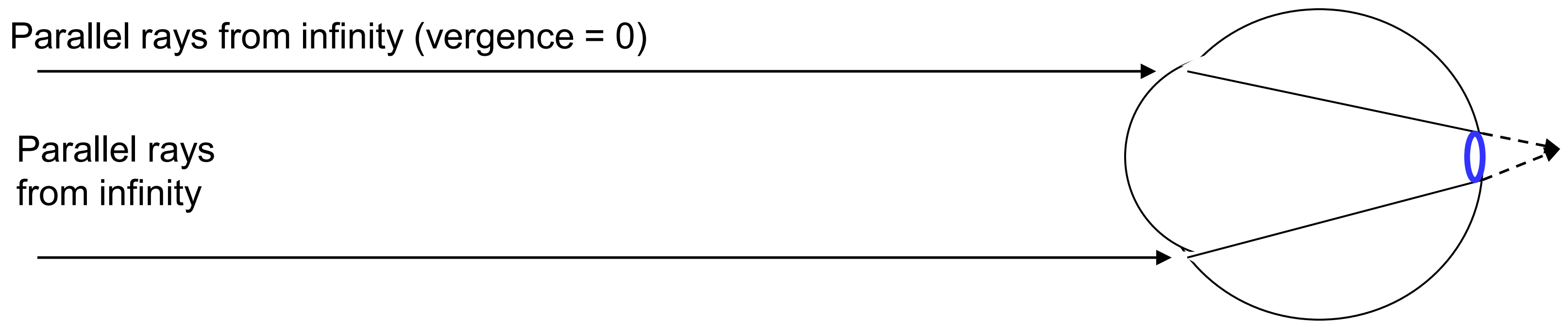


Now consider the **hyperope**.
In the hyperopic eye, rays from infinity never meet—they run out of eyeball first.
Thus, like the myopic eye, the rays form a blur circle, not a focal point, at the retina.

Refractive Surgery Overview

The Hyperopic Eye

The hyperopic eye has too little converging power for its length

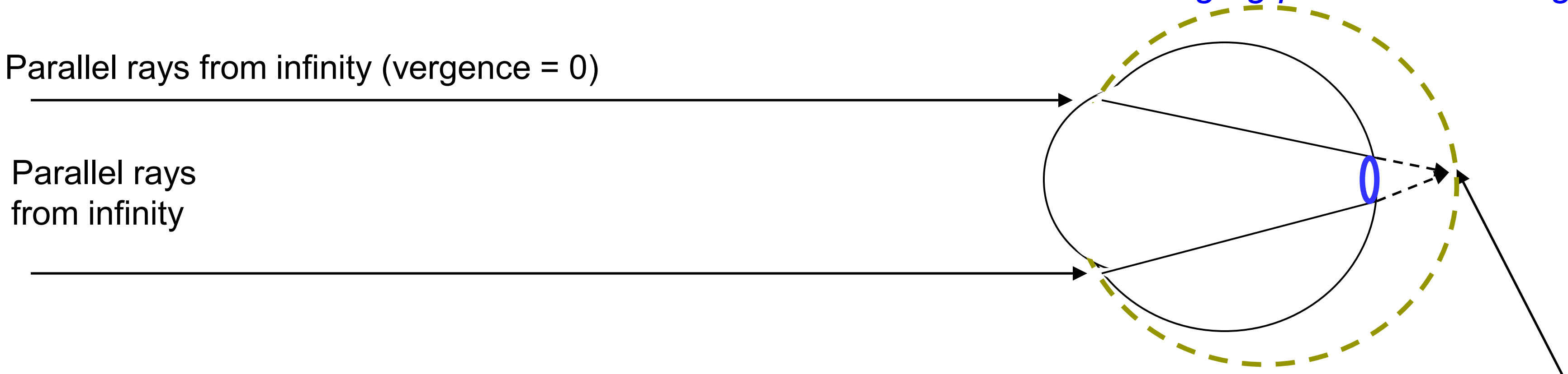


Now consider the **hyperope**.
In the hyperopic eye, rays from infinity never meet—they run out of eyeball first.
Thus, like the myopic eye, the rays form a blur circle, not a focal point, at the retina.
You could say the hyperopic eye has too *little* converging power for its length.

Refractive Surgery Overview

The Hyperopic Eye

The hyperopic eye has too little converging power for its length



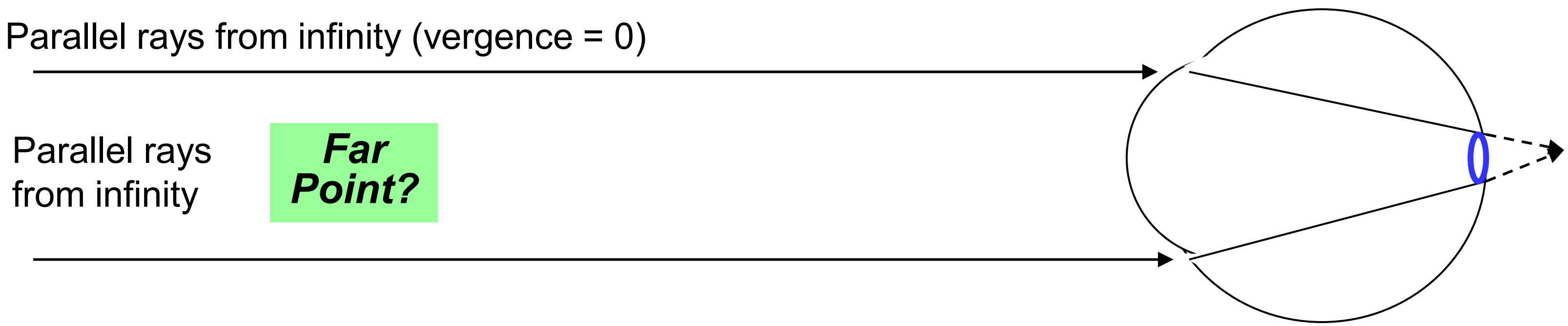
Note that if the retina was *here*, the rays from infinity would be focused to a point.

Now consider the **hyperope**.
In the hyperopic eye, rays from infinity never meet—they run out of eyeball first.
Thus, like the myopic eye, the rays form a blur circle, not a focal point, at the retina.
You could say the hyperopic eye has too *little* converging power for its length.

Refractive Surgery Overview

The Hyperopic Eye

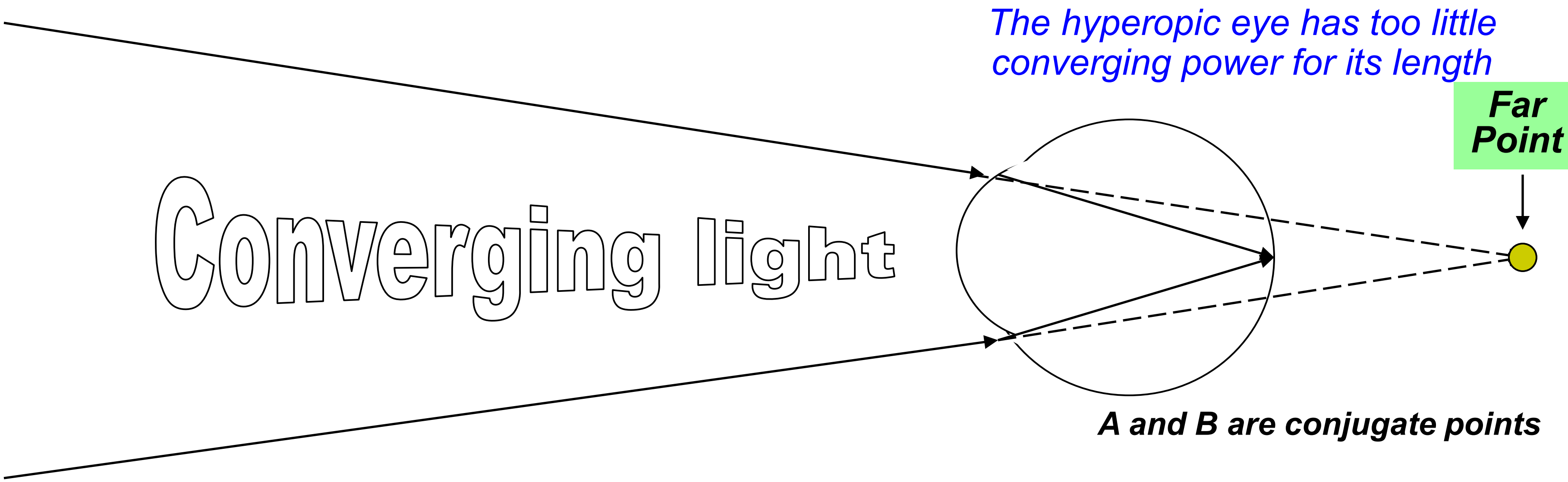
The hyperopic eye has too little converging power for its length



Now consider the **hyperope**.
In the hyperopic eye, rays from infinity never meet—they run out of eyeball first.
Thus, like the myopic eye, the rays form a blur circle, not a focal point, at the retina.
You could say the hyperopic eye has too *little* converging power for its length.
In order to be conjugate to the retina, the Far Point of a hyperopic eye must contribute convergence to compensate for this lack of converging power.
To accomplish this…

Refractive Surgery Overview

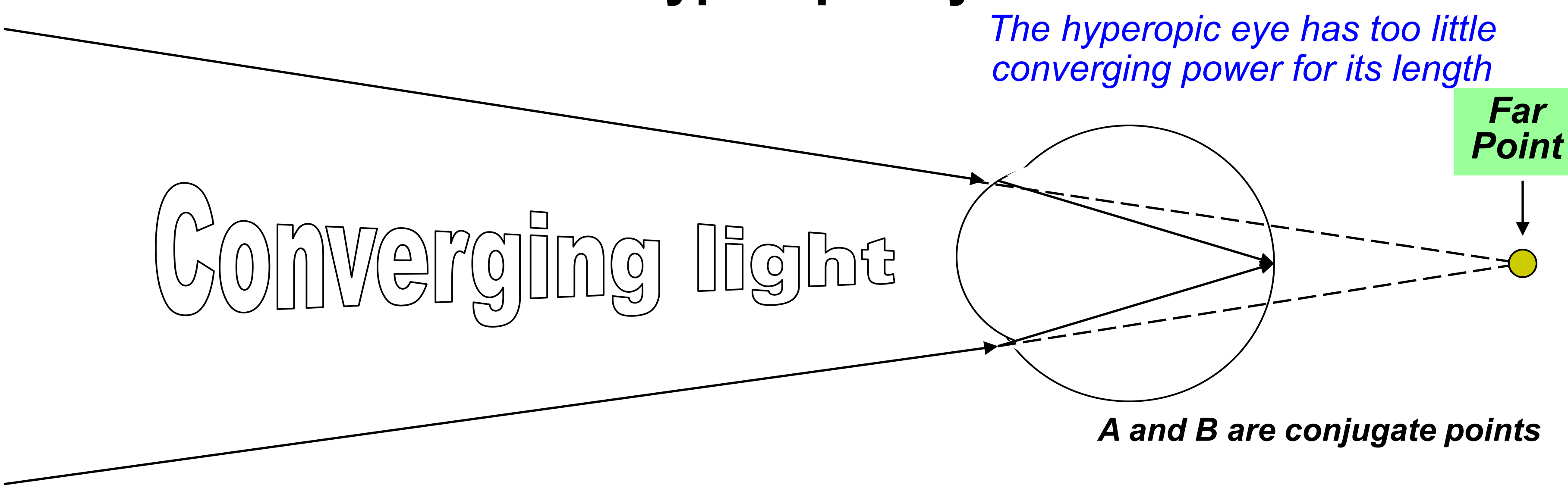
The Hyperopic Eye



…the far point of a hyperopic eye is *behind* the corneal plane. It contributes **convergence** to make up for the inadequate native convergence of the hyperopic eye.

Refractive Surgery Overview

The Hyperopic Eye

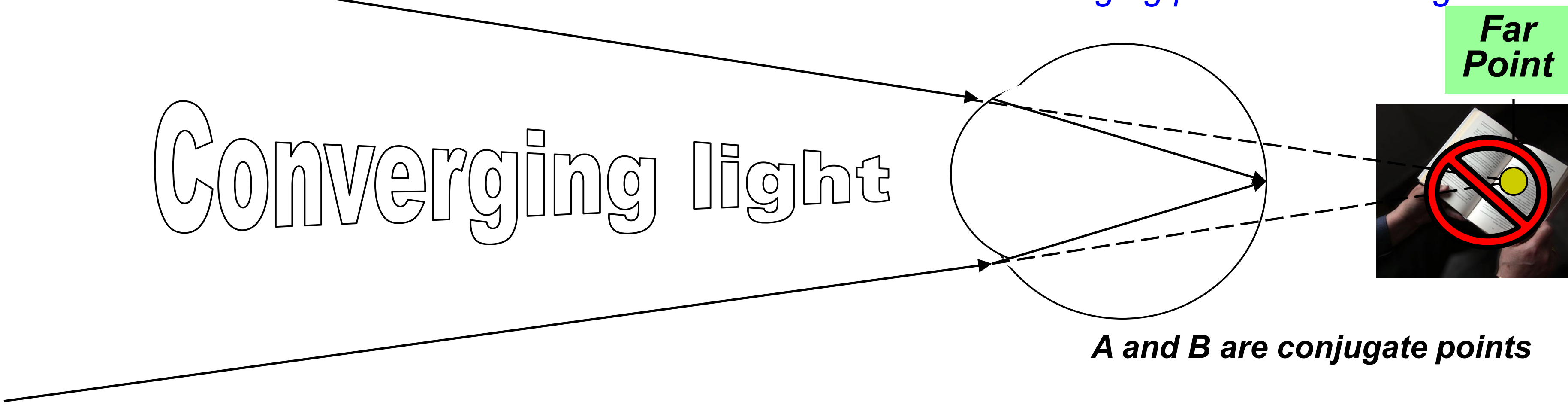


…the far point of a hyperopic eye is *behind* the corneal plane. It contributes **convergence** to make up for the inadequate native convergence of the hyperopic eye. Thus, rays associated with the far point end up sharply focused at the retina.

Refractive Surgery Overview

The Hyperopic Eye

The hyperopic eye has too little converging power for its length

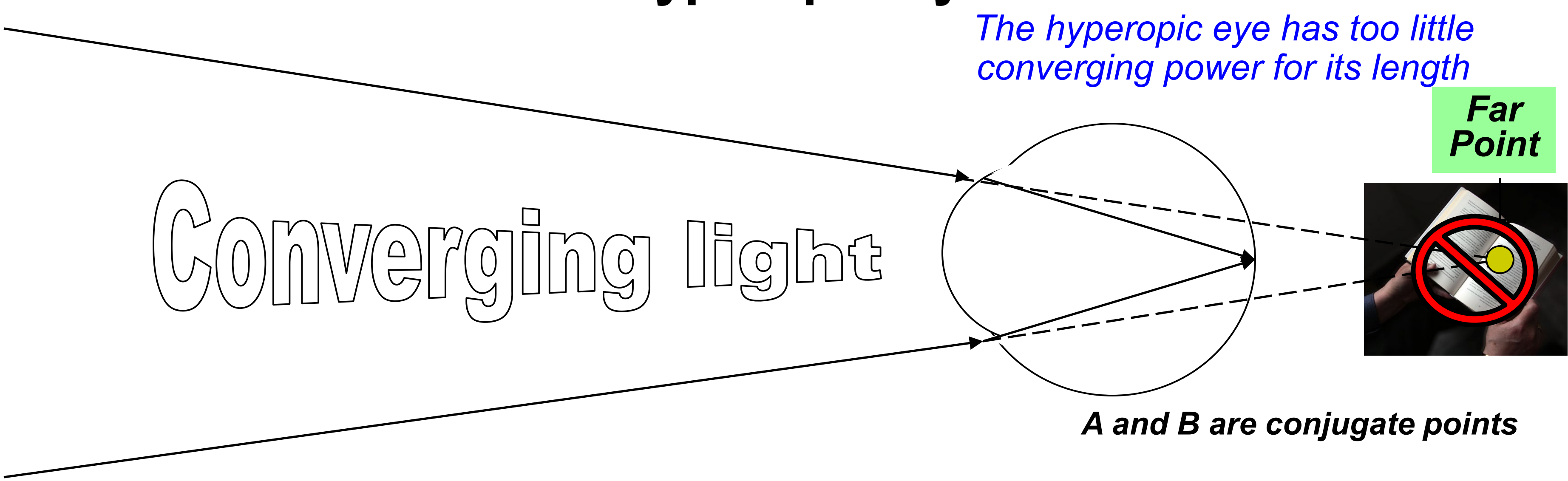


A and B are conjugate points

…the far point of a hyperopic eye is *behind* the corneal plane. It contributes **convergence** to make up for the inadequate native convergence of the hyperopic eye. Thus, rays associated with the far point end up sharply focused at the retina. Don't get it twisted—hyperopes can't actually see behind their heads. (Do I really have to say that?)

Refractive Surgery Overview

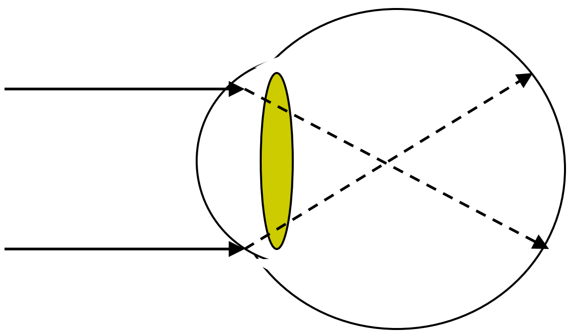
The Hyperopic Eye



…the far point of a hyperopic eye is *behind* the corneal plane. It contributes **convergence** to make up for the inadequate native convergence of the hyperopic eye. Thus, rays associated with the far point end up sharply focused at the retina. Don't get it twisted—hyperopes can't actually see behind their heads. (Do I really have to say that?) Unlike myopes—who can see at their far point just out in front of their faces—a hyperope is out of focus at **all** distances (absent correction or accommodation.)

Refractive Surgery Overview

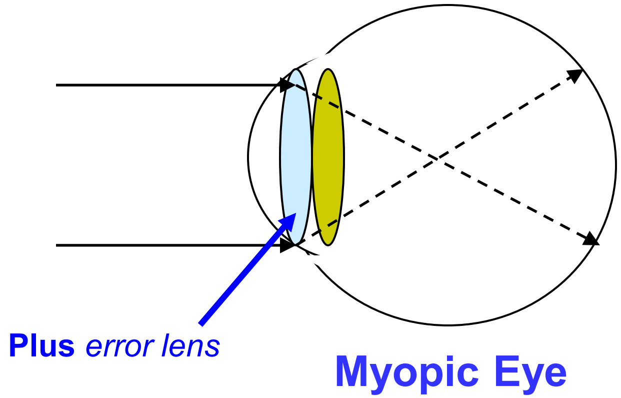
- The myopic eye has too much *converging* power for its length, as we said



Myopic Eye

Refractive Surgery Overview

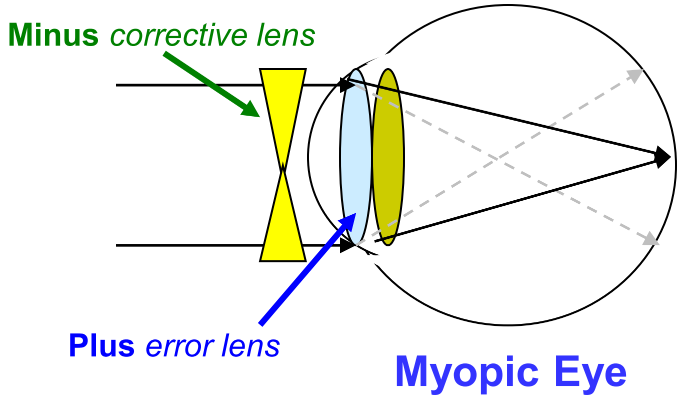
- The myopic eye has too much *converging* power for its length, as we said



Think of it this way: The myopic eye refracts light as if an extra ‘plus’ lens was built into it. This so-called **error lens** contributes the excess convergence that produces a myopic refractive error.

Refractive Surgery Overview

- The myopic eye has too much *converging* power for its length, as we said

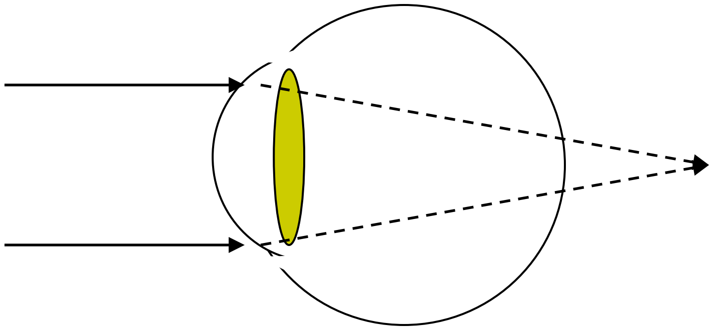


This explains why **myopes wear minus lenses** to correct their refractive error—minus lenses are needed to offset the excess convergence induced by the plus error lenses in their eyes.

Think of it this way: The **myopic eye refracts light as if an extra 'plus' lens was built into it.** This so-called **error lens** contributes the excess convergence that produces a myopic refractive error.

Refractive Surgery Overview

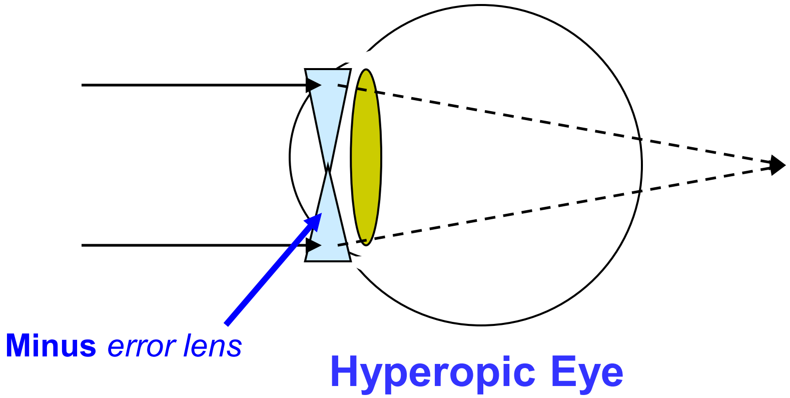
- The myopic eye has too much *converging* power for its length, as we said
- In contrast, the hyperopic eye has too much *diverging* power for its length



Hyperopic Eye

Refractive Surgery Overview

- The myopic eye has too much *converging* power for its length, as we said
- In contrast, the hyperopic eye has too much *diverging* power for its length

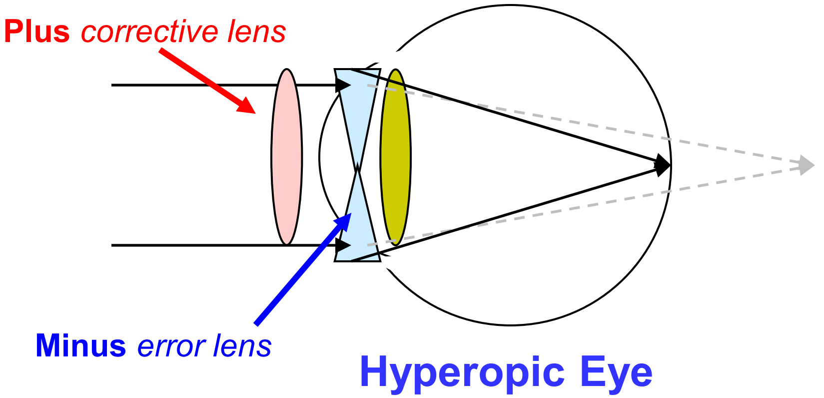


Thus, the hyperopic eye acts as if it has a *minus* error lens within it, contributing the excess divergence resulting in a hyperopic refractive error.

Refractive Surgery Overview

- The myopic eye has too much *converging* power for its length, as we said
- In contrast, the hyperopic eye has too much *diverging* power for its length

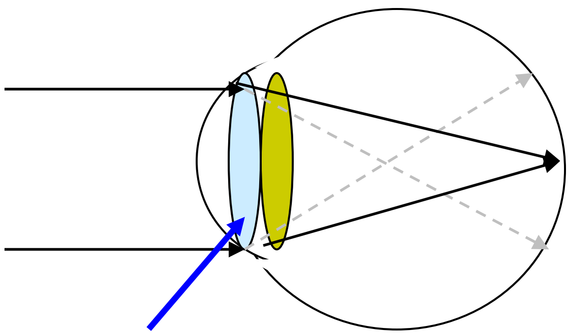
This explains why **hyperopes wear plus lenses** to correct their refractive error—plus lenses are needed to offset the excess divergence induced by the minus error lenses in their eyes.



Thus, the **hyperopic eye acts as if it has a *minus* error lens within it**, contributing the excess divergence resulting in a hyperopic refractive error.

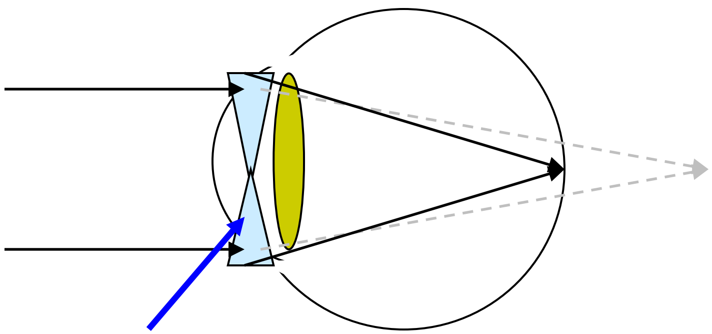
Refractive Surgery Overview

The goal of refractive surgery is to produce an error-lens offset that is incorporated into the eye itself, *rather than worn on (CLs) or near (glasses) its anterior surface.*



Plus *error lens*

Myopic Eye



Minus *error lens*

Hyperopic Eye

Refractive Surgery Overview

Refractive Surgery

Intraocular | Corneal

As mentioned previously, refractive surgical procedures come in two basic forms—*intraocular* and *corneal*.

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

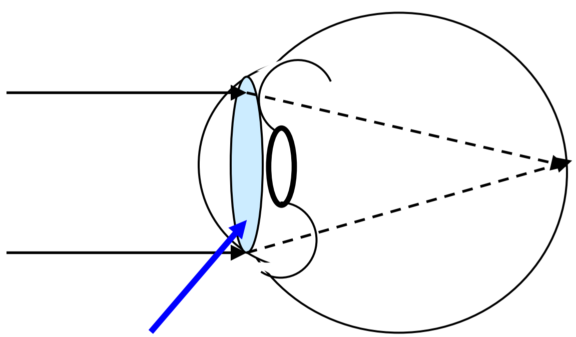
Likewise, **intraocular procedures** come in two forms—*pseudophakic*, and *phakic IOL* (PIOL).

Refractive Surgery Overview

Refractive Surgery

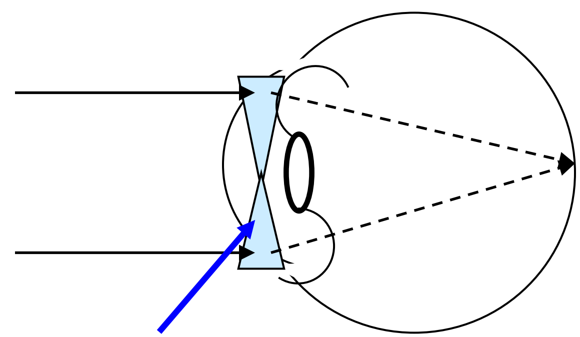
- Intraocular
  - **Pseudophakic**
  - Phakic IOL
- Corneal

A *pseudophakic procedure* involves removing the native lens and replacing it with an IOL powered to put parallel rays on the retina. The surgery is identical to that performed for cataracts. (Such procedures are referred to as ‘clear lens extraction.’)



Plus *error lens*

Myopic Eye



Minus *error lens*

Hyperopic Eye

Refractive Surgery Overview

Refractive Surgery

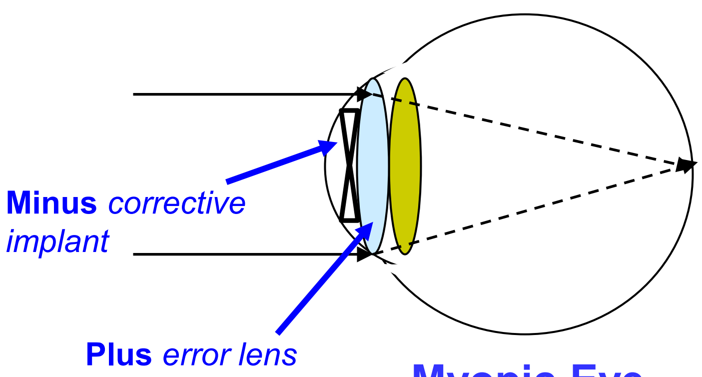
Intraocular

Corneal

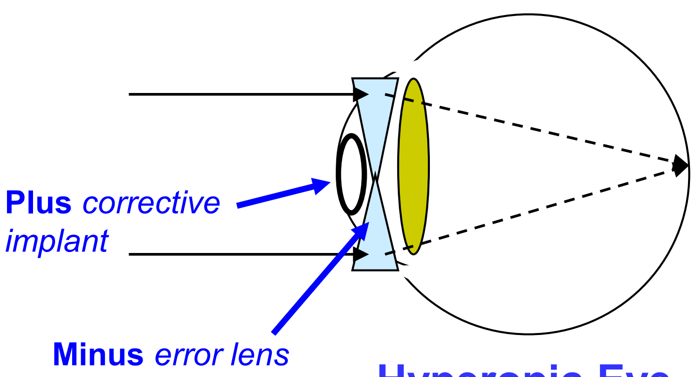
Pseudophakic

Phakic IOL

In a *phakic IOL procedure* the native lens is left in place, and a corrective lens is placed in front of it—an 'intraocular contact lens' if you will.



Myopic Eye

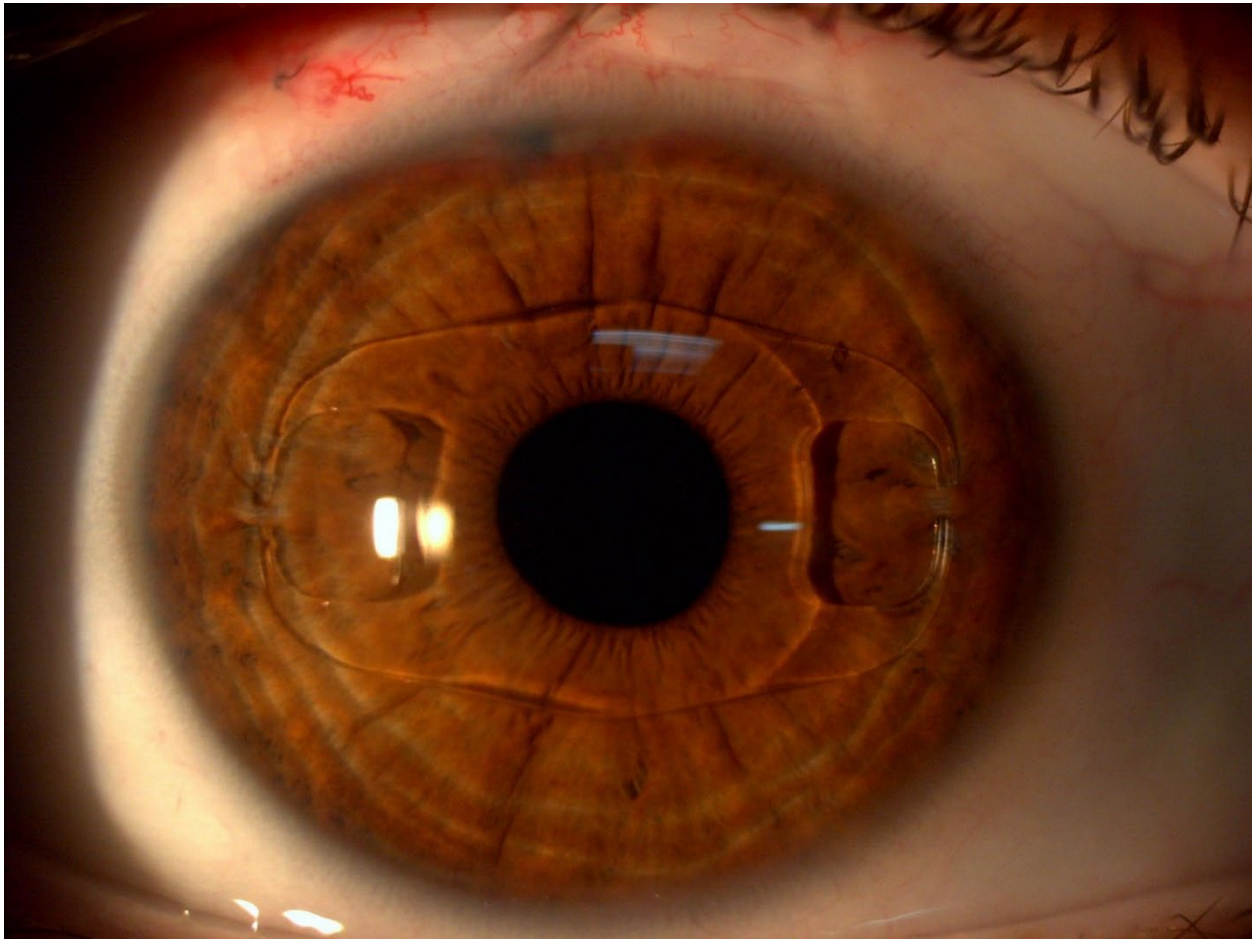


Hyperopic Eye

Refractive Surgery Overview

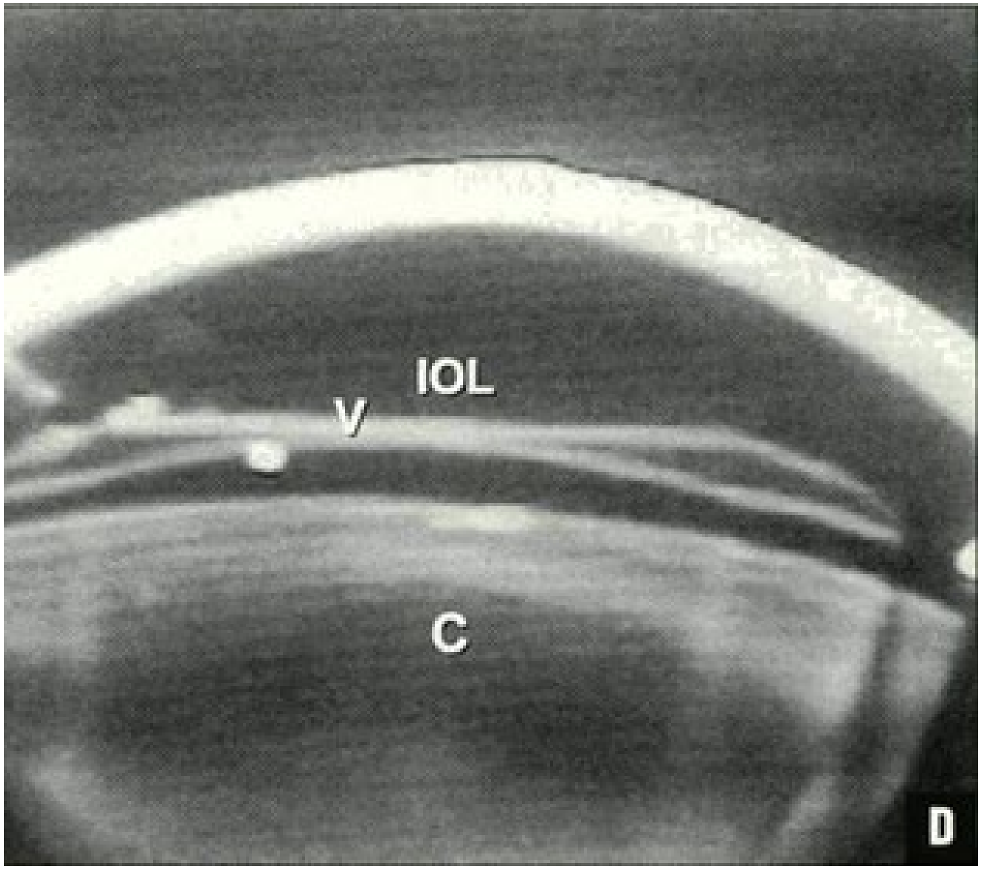
Phakic IOL

Refractive Surgery Overview



Phakic IOL

Refractive Surgery Overview



Phakic IOL vaulting over the native lens

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

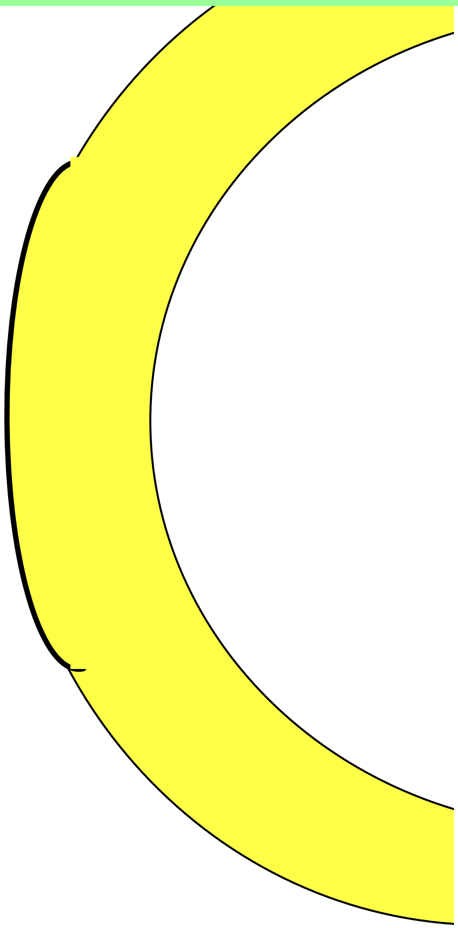
Pseudophakic

Phakic IOL

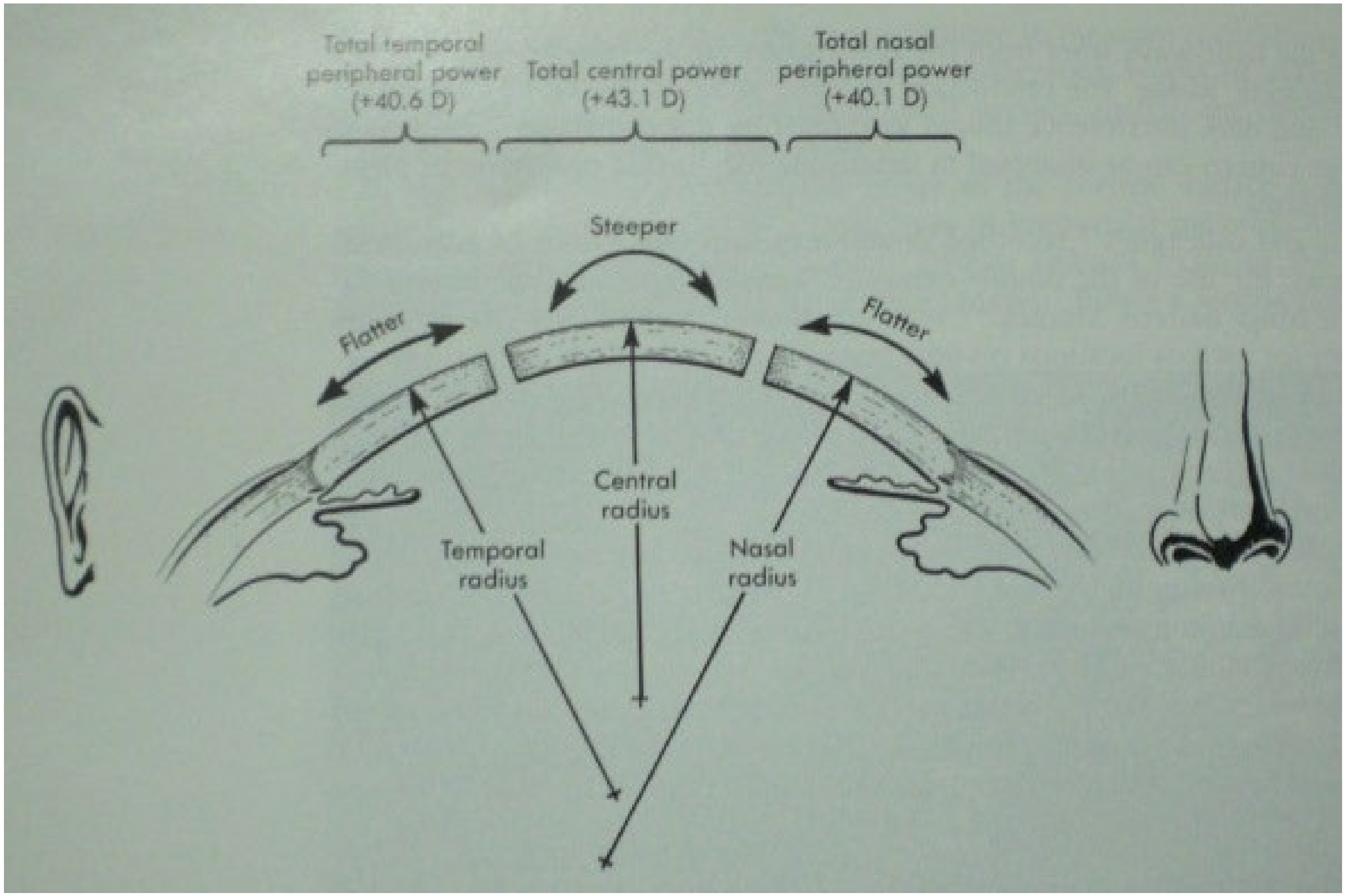
Before we get into cornea-based refractive surgeries, let's take a look at corneal optics

Refractive Surgery Overview

The shape of the human cornea is *prolate*, which means the central portion is steeper (ie, has a shorter radius of curvature) than the peripheral portion. On average, the central cornea is 3-4D steeper than the periphery.



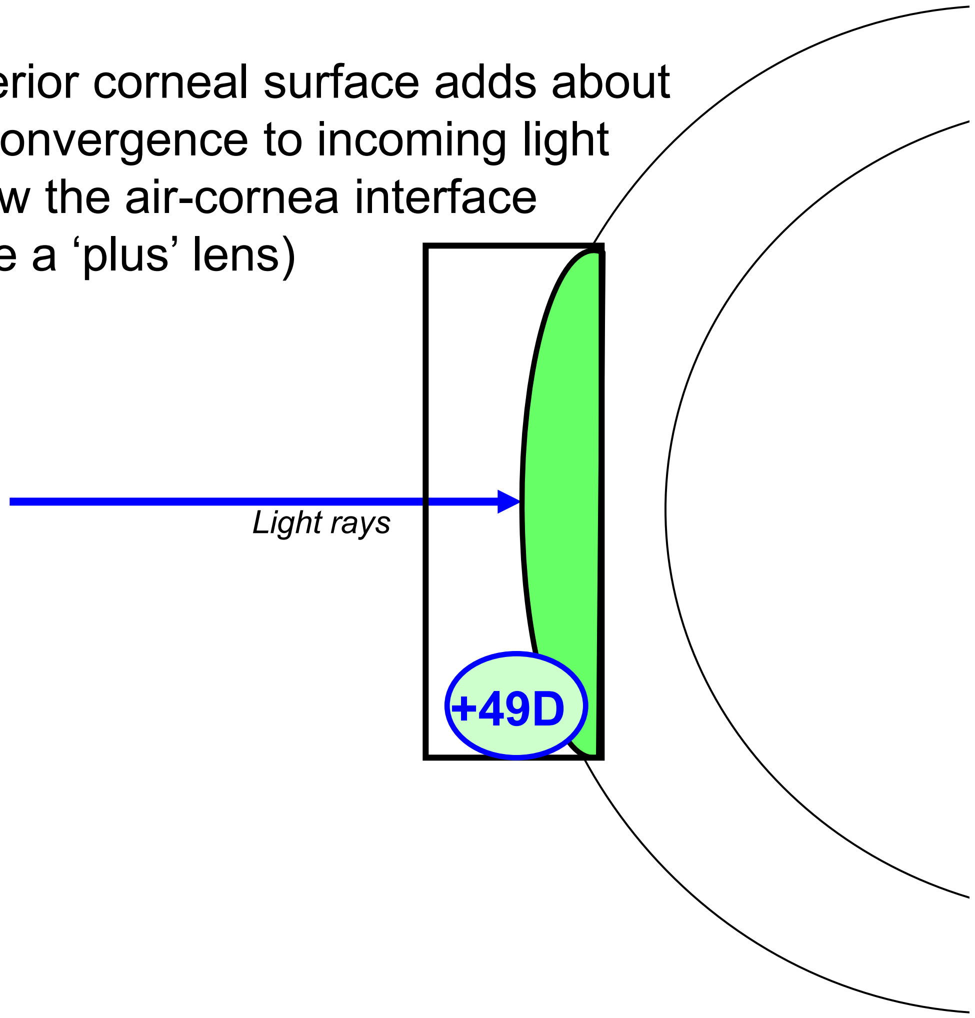
Refractive Surgery Overview



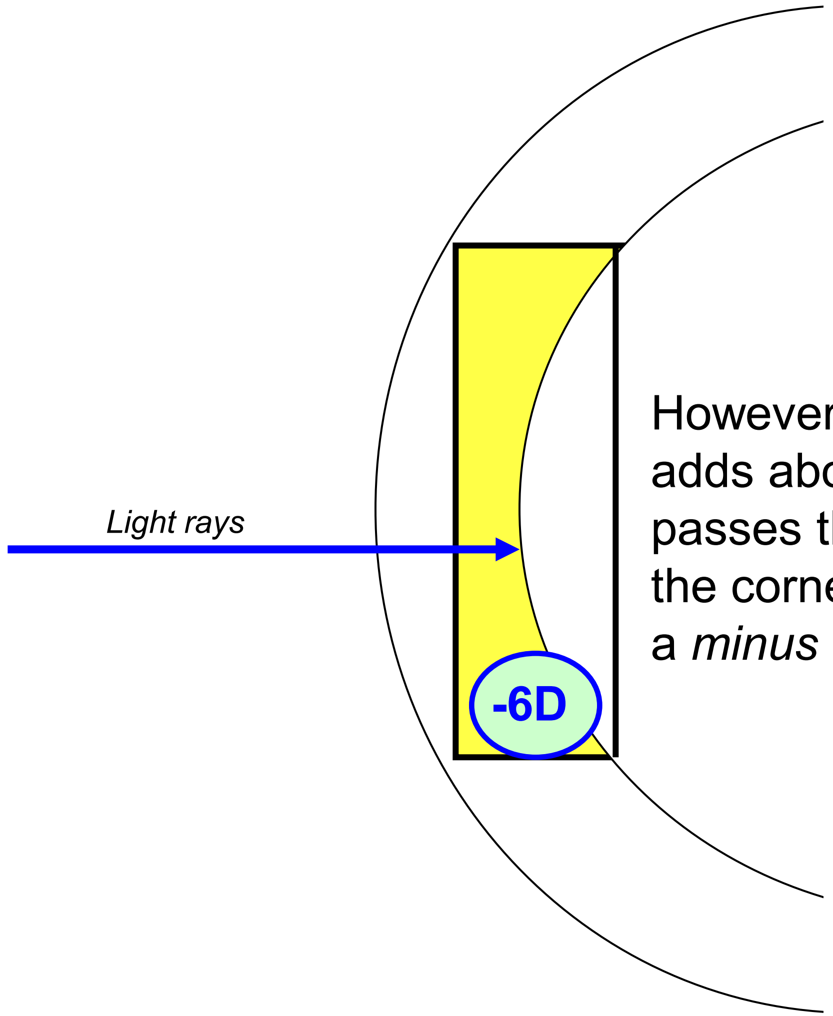
Power differential of central vs peripheral cornea
(don’t memorize the numbers)

Refractive Surgery Overview

The anterior corneal surface adds about **49D** of convergence to incoming light (note how the air-cornea interface looks like a ‘plus’ lens)

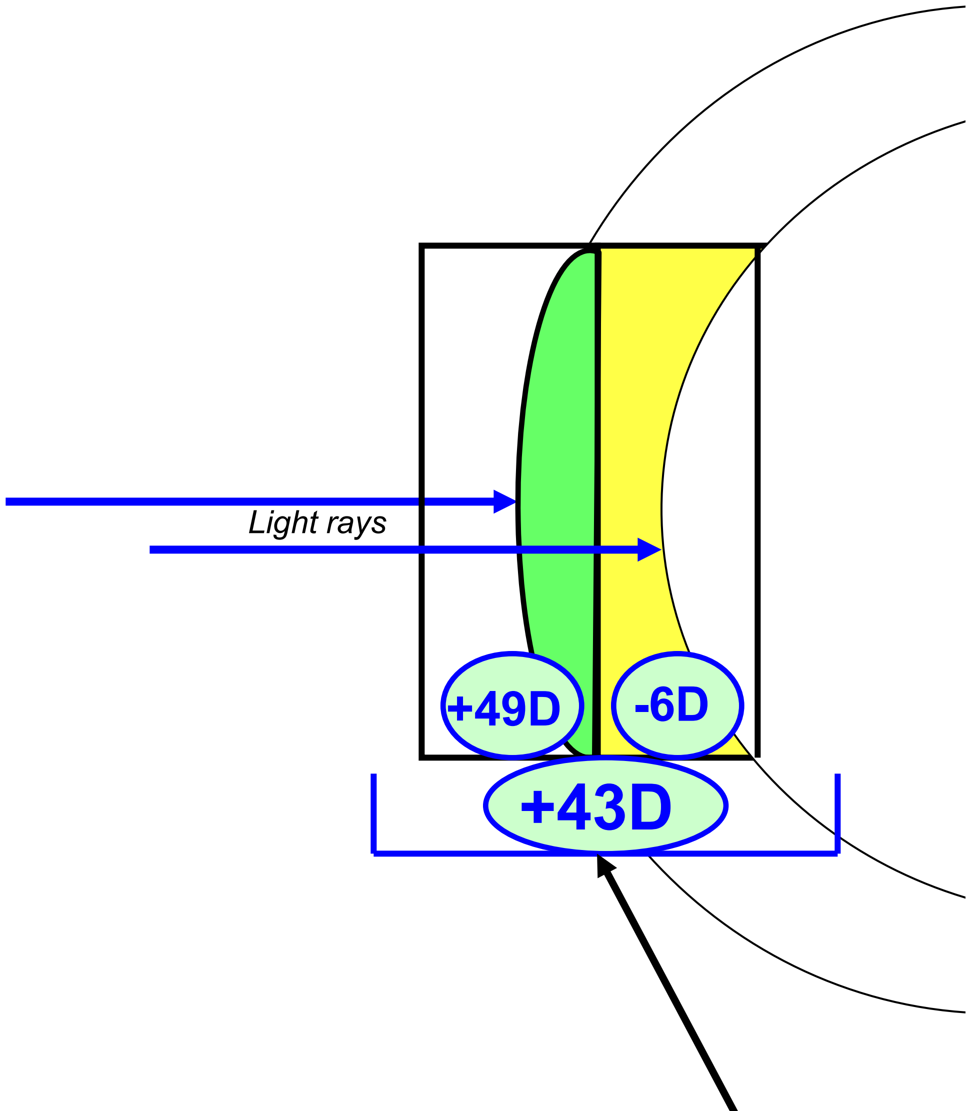


Refractive Surgery Overview



However, the posterior corneal surface adds about **6D** of *divergence* as light passes through it into the AC (note how the cornea-aqueous interface looks like a *minus* lens)

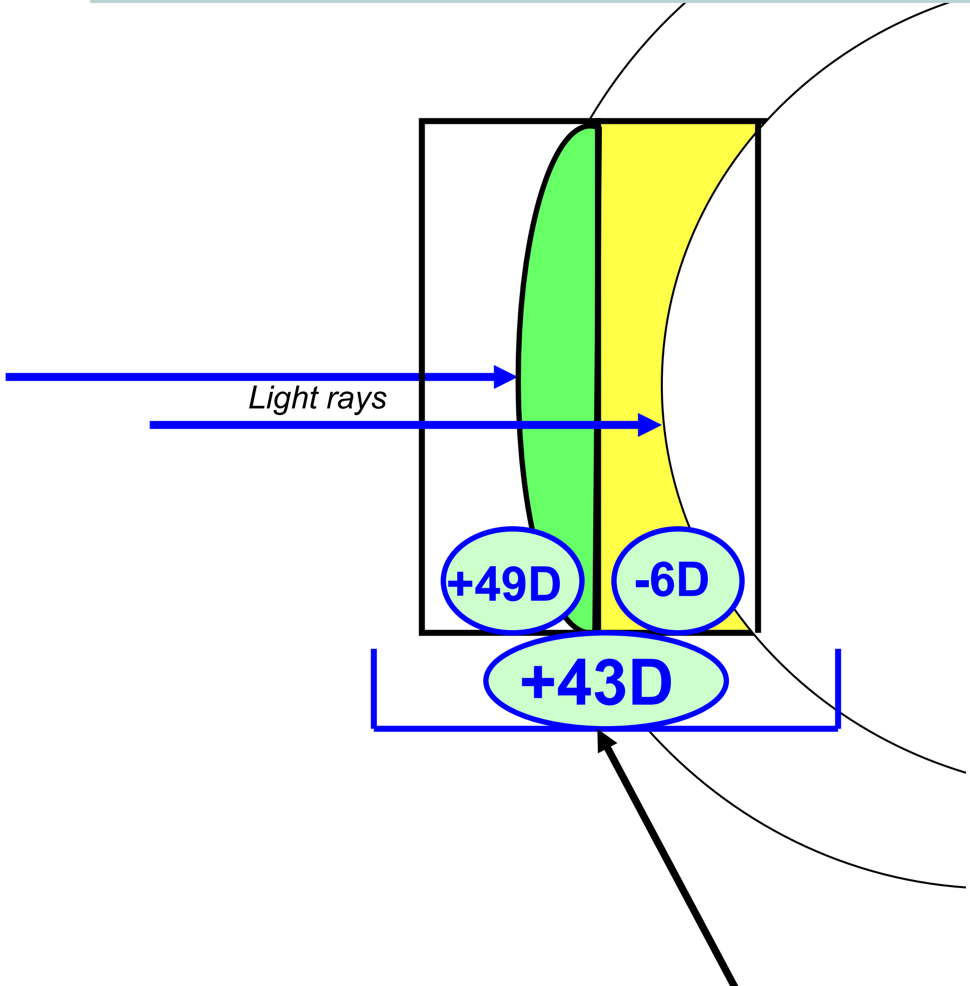
Refractive Surgery Overview



The net result across the cornea is an **overall power of about +43D**

Refractive Surgery Overview

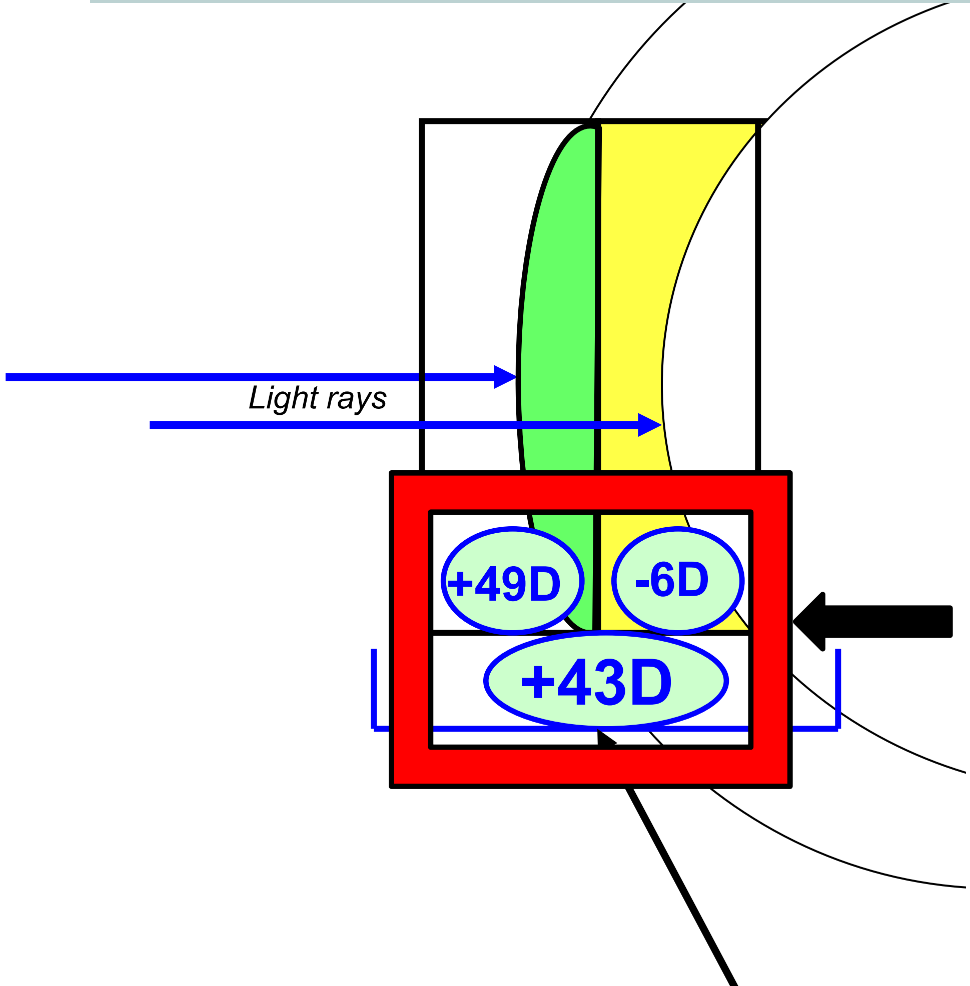
The human eye averages about 60D of total convergence, implying (correctly) that the cornea accounts for roughly 2/3 of its focusing power



The net result across the cornea is an **overall power of about +43D**

Refractive Surgery Overview

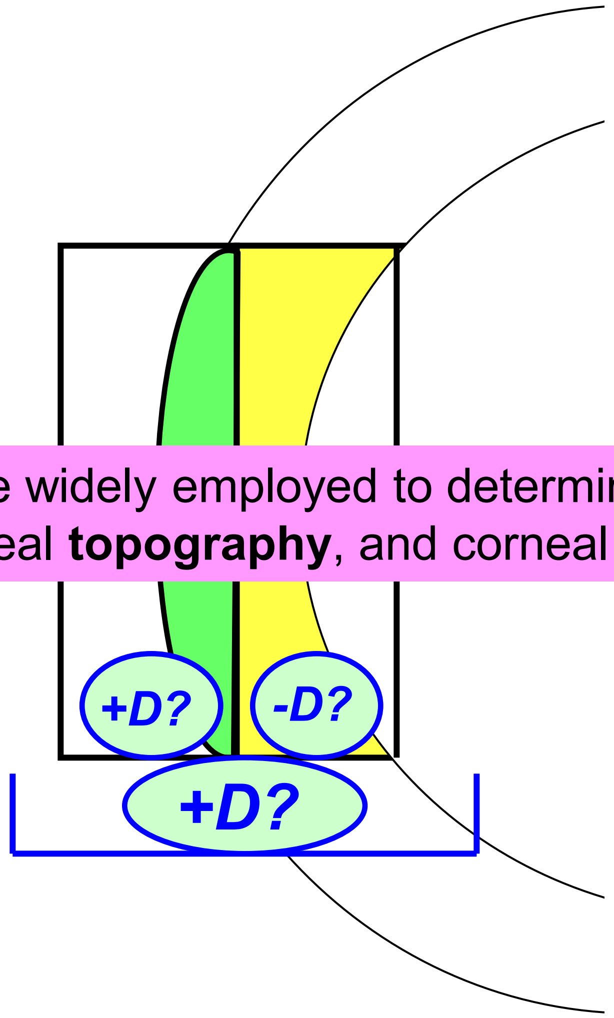
The human eye averages about 60D of total convergence, implying (correctly) that the cornea accounts for roughly 2/3 of its focusing power



Of course, these are only averages. In order to perform keratorefractive surgery, one must have accurate measurements of central corneal power—ideally, at both its anterior and posterior surfaces.

The net result across the cornea is an **overall power of about +43D**

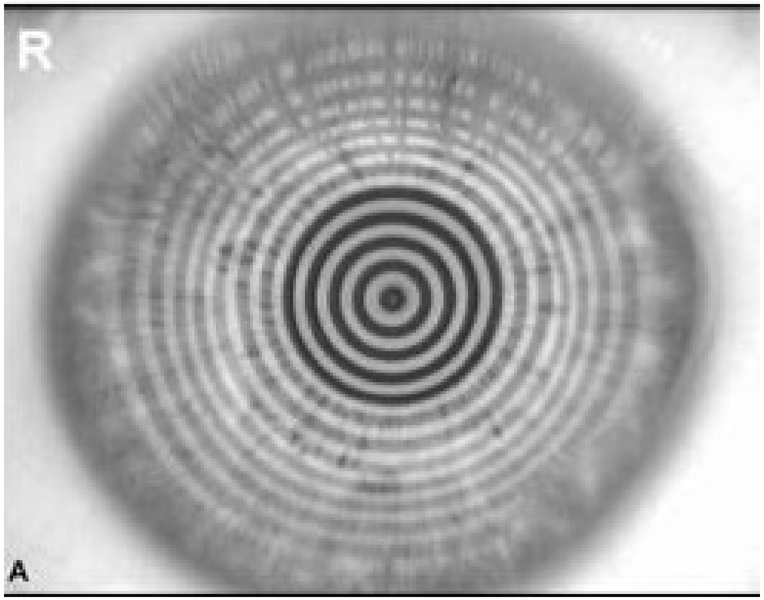
Refractive Surgery Overview



Two technologies are widely employed to determine central corneal power: Corneal **topography**, and corneal **tomography**

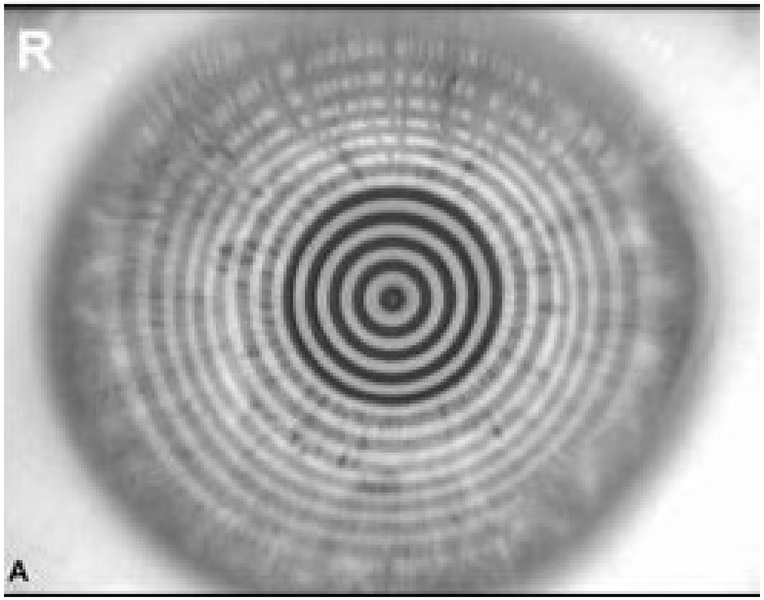
Refractive Surgery Overview

Corneal topography works by reflecting a set of concentric rings (collectively called a *Placido disk*) from the anterior corneal surface, and a computer analyzes the distances between, and shapes of, the reflected rings.



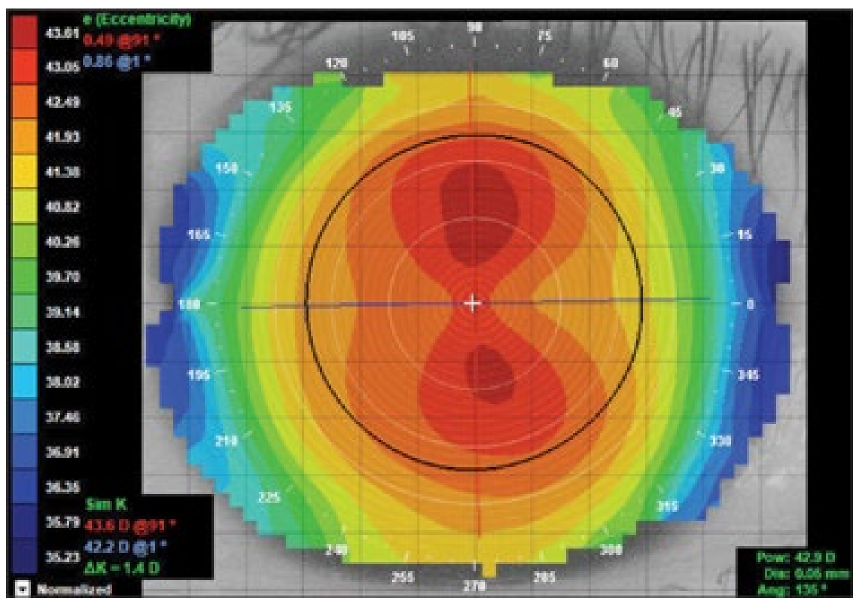
Refractive Surgery Overview

Corneal topography works by reflecting a set of concentric rings (collectively called a *Placido disk*) from the anterior corneal surface, and a computer analyzes the distances between, and shapes of, the reflected rings. Based on this analysis, the topographer creates a color-coded 'map' depicting the curvature across the corneal surface.



Refractive Surgery Overview

Corneal topography works by reflecting a set of concentric rings (collectively called a *Placido disk*) from the anterior corneal surface, and a computer analyzes the distances between, and shapes of, the reflected rings. Based on this analysis, the topographer creates a color-coded 'map' depicting the curvature across the corneal surface.



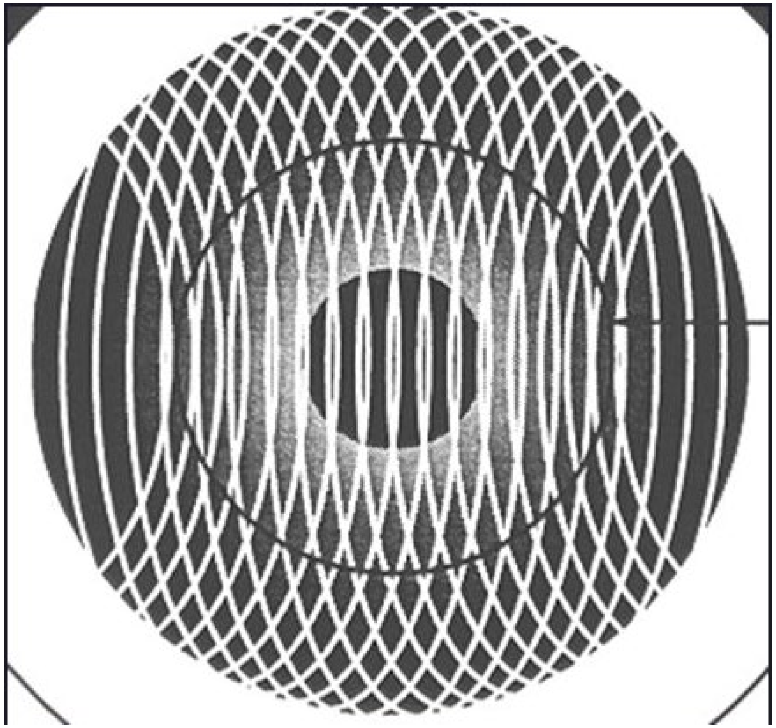
Corneal Placido-disk topography: Color map demonstrating *with-the-rule astigmatism* (ie, the cornea is steeper in its vertical meridian)

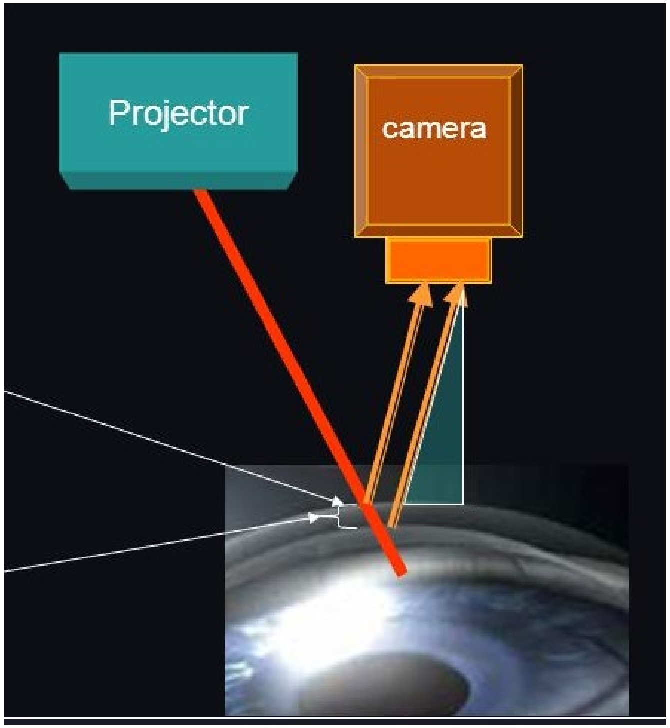
Refractive Surgery Overview

Corneal tomography works by mapping the anterior and posterior corneal surfaces in relation to one another. It allows for 3-D modeling of the cornea, including both anterior and posterior surface curvature and corneal thickness.

Refractive Surgery Overview

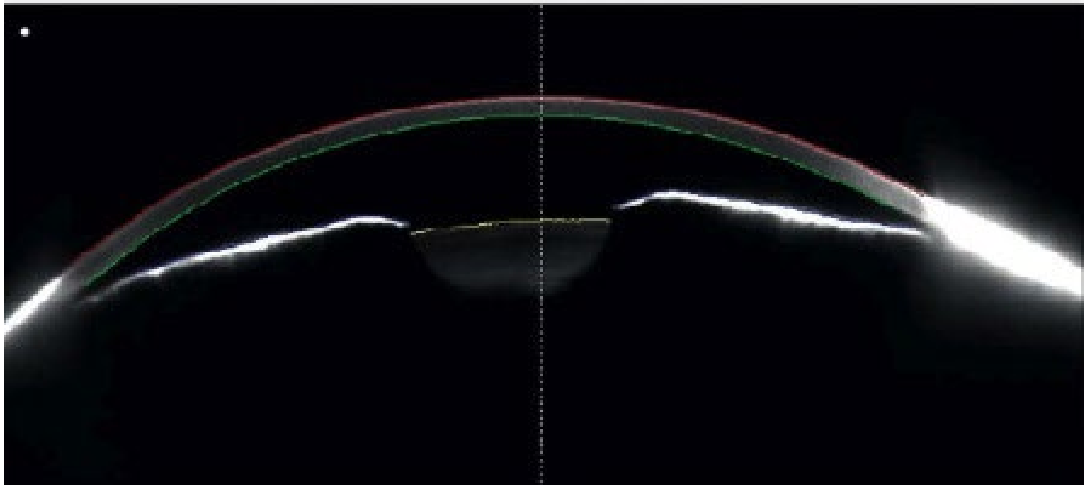
Corneal tomography works by mapping the anterior and posterior corneal surfaces in relation to one another. It allows for 3-D modeling of the cornea, including both anterior and posterior surface curvature and corneal thickness.
The data are acquired via one of two technologies (or both in combination):
--*Scanning-slit*: A series of overlapping scans are directed at the cornea. The light reflects off both the anterior and posterior surfaces. These reflections are acquired and analyzed to produce a model of the central cornea.





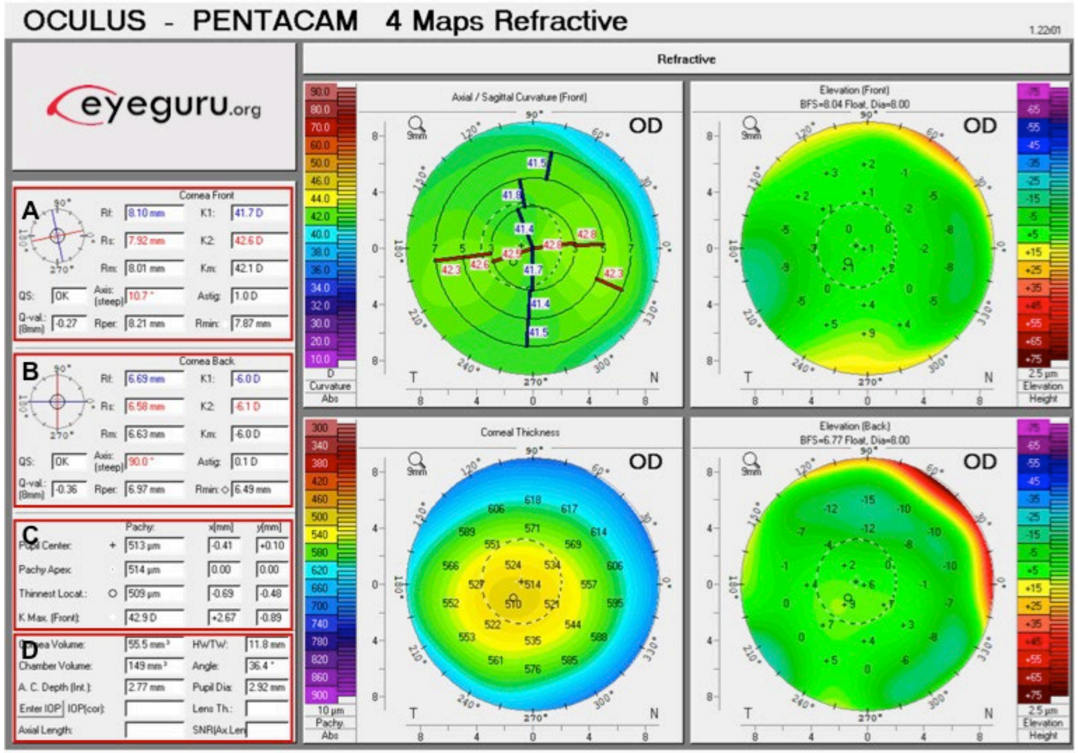
Refractive Surgery Overview

Corneal tomography works by mapping the anterior and posterior corneal surfaces in relation to one another. It allows for 3-D modeling of the cornea, including both anterior and posterior surface curvature and corneal thickness.
The data are acquired via one of two technologies (or both in combination):
--*Scanning-slit*: A series of overlapping scans are directed at the cornea. The light reflects off both the anterior and posterior surfaces. These reflections are acquired and analyzed to produce a model of the central cornea.
--*Scheimpflug imaging*: A series of Scheimpflug images are taken and analyzed with respect to anterior and posterior corneal curvature and corneal thickness. The data from each image are knitted together to produce a model of the cornea.



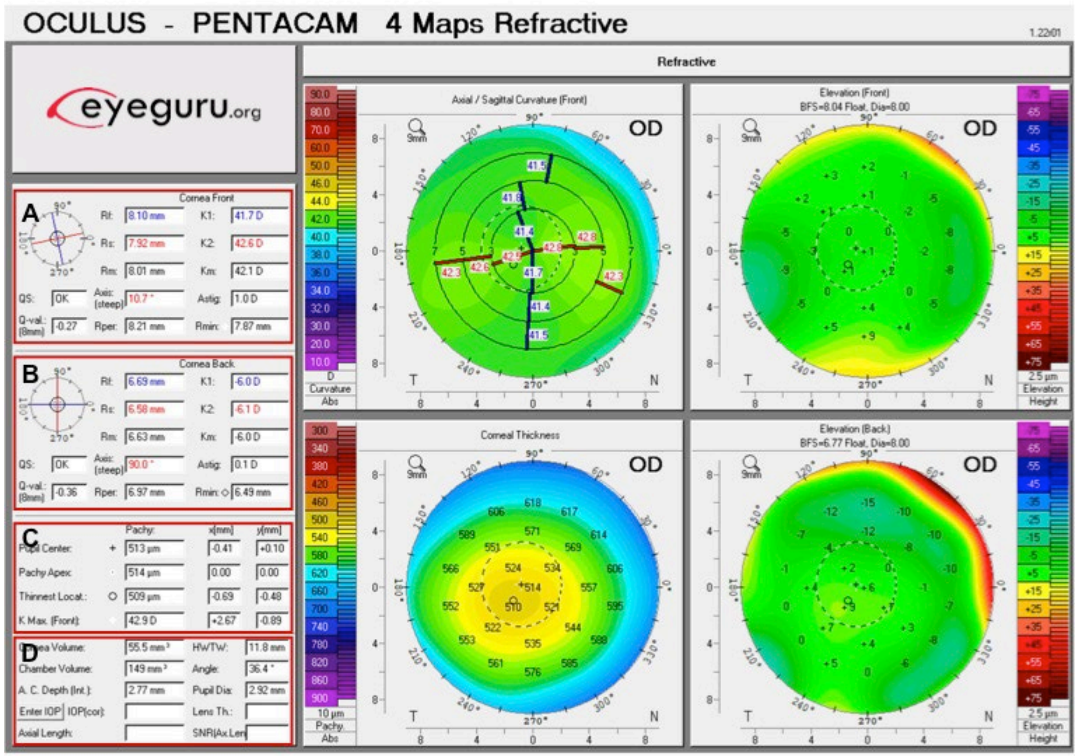
Scheimpflug image of the cornea

Refractive Surgery Overview



Pentacam corneal tomographer readout

Refractive Surgery Overview



Pentacam corneal tomographer readout

A) Anterior corneal values

•K_1, K_2, K_m: The two major meridians (**K_1, K_2**). **K_m** is the average of **K_1** and **K_2**

•R_f, R_s, R_m: Radii corresponding with **K_1, K_2, and K_m**, respectively

•QS: Quality score (I.e. "OK," "Data gaps," "Fix," "Model)

•Axis: The meridian that requires no cylinder power to correct astigmatism

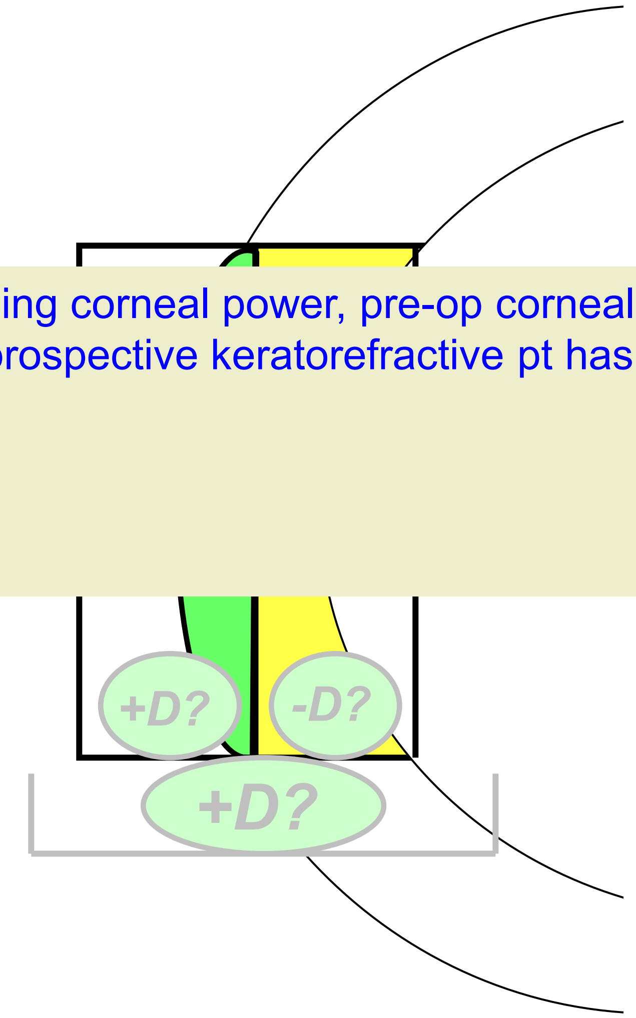
•Astig: The central corneal astigmatism

B) Posterior corneal values

The same variables described for the back of the cornea.

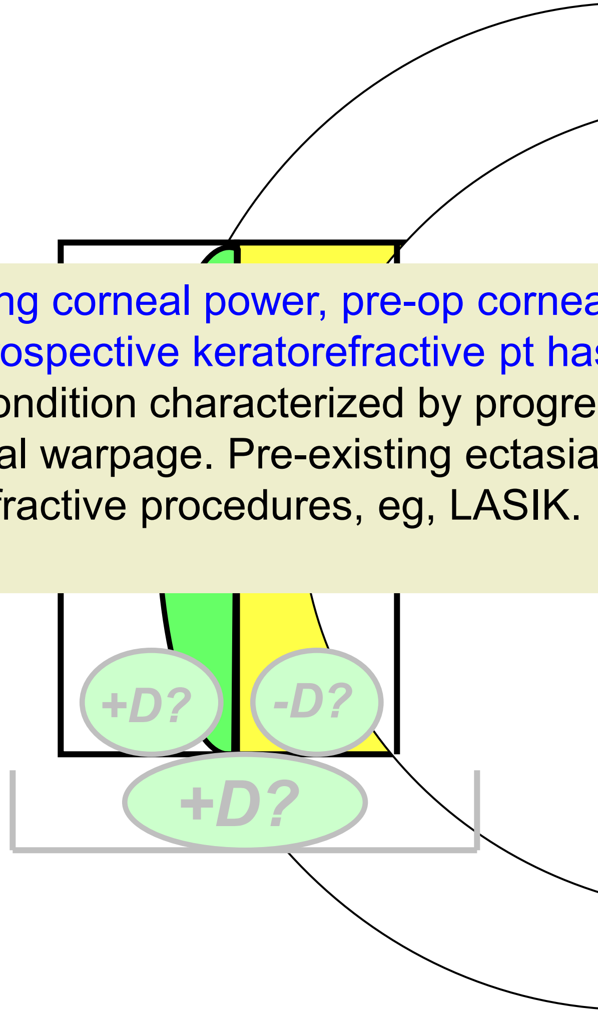
C), D) Fuggedaboudit (too much for this overview)

Refractive Surgery Overview



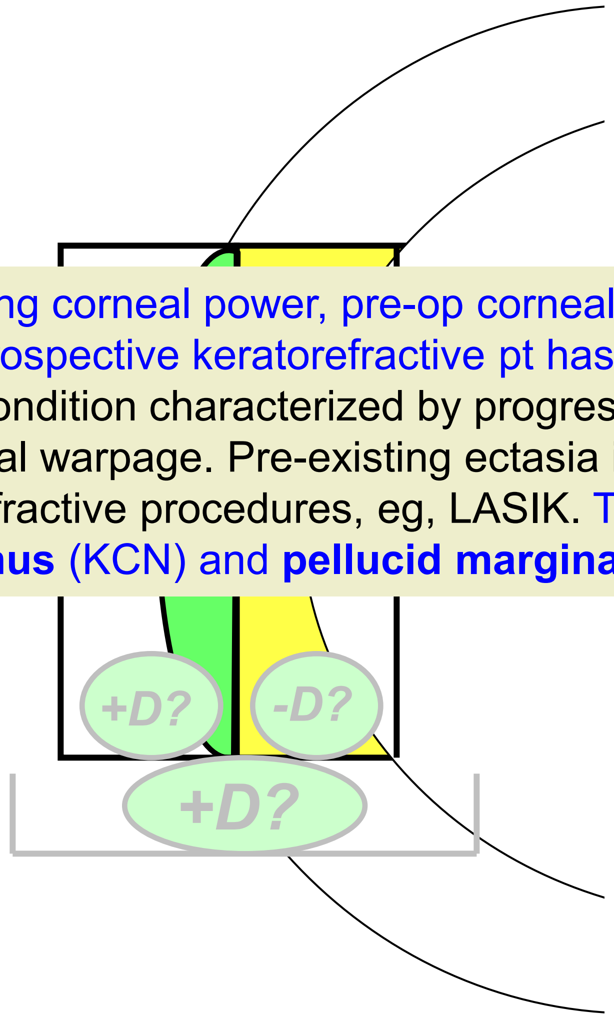
In addition to determining corneal power, pre-op corneal mapping is employed to determine whether a prospective keratorefractive pt has a *corneal ectasia*.

Refractive Surgery Overview



In addition to determining corneal power, pre-op corneal mapping is employed to determine whether a prospective keratorefractive pt has a *corneal ectasia*. An ectasia is a noninflammatory condition characterized by progressive corneal thinning, the end result of which is corneal warpage. Pre-existing ectasia is a strong contraindication to many elective keratorefractive procedures, eg, LASIK.

Refractive Surgery Overview

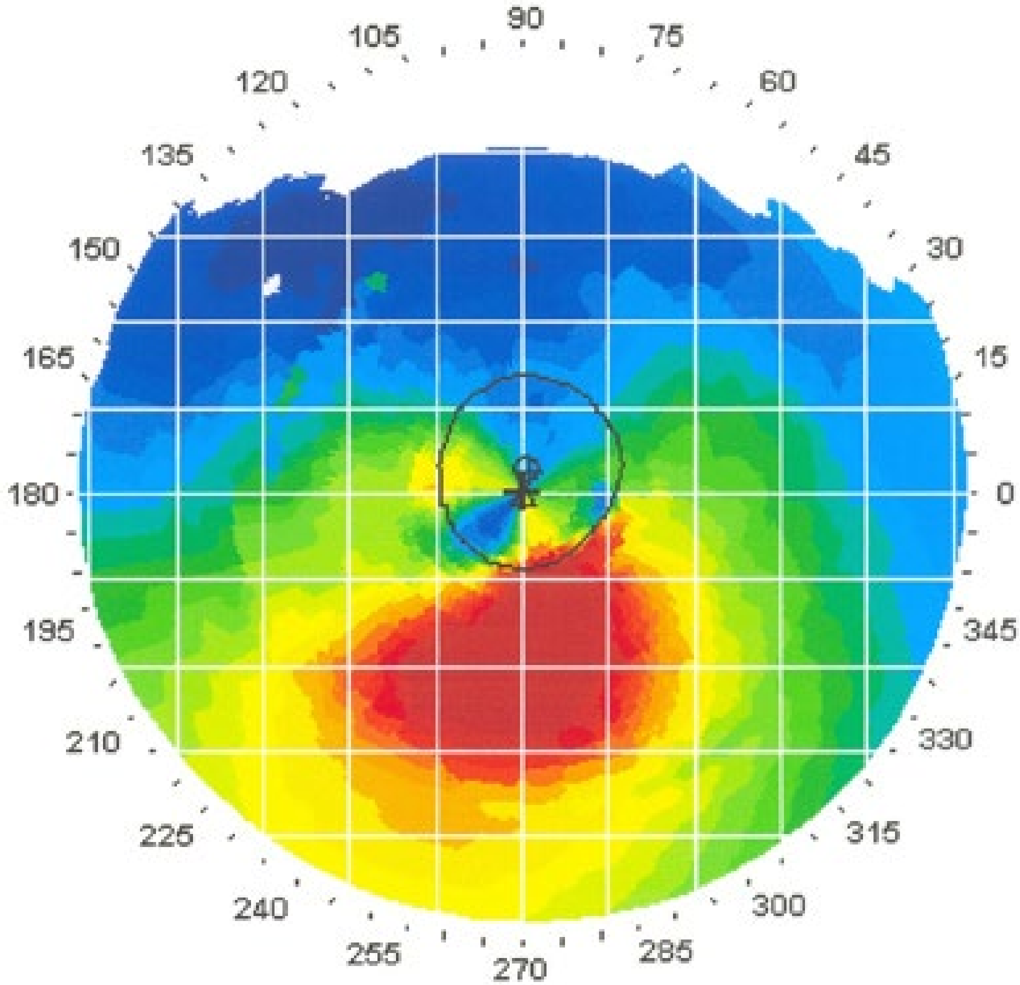


In addition to determining corneal power, pre-op corneal mapping is employed to determine whether a prospective keratorefractive pt has a *corneal ectasia*. An ectasia is a noninflammatory condition characterized by progressive corneal thinning, the end result of which is corneal warpage. Pre-existing ectasia is a strong contraindication to many elective keratorefractive procedures, eg, LASIK. The two most common ectasias are **keratoconus** (KCN) and **pellucid marginal degeneration** (PMD).

Refractive Surgery Overview

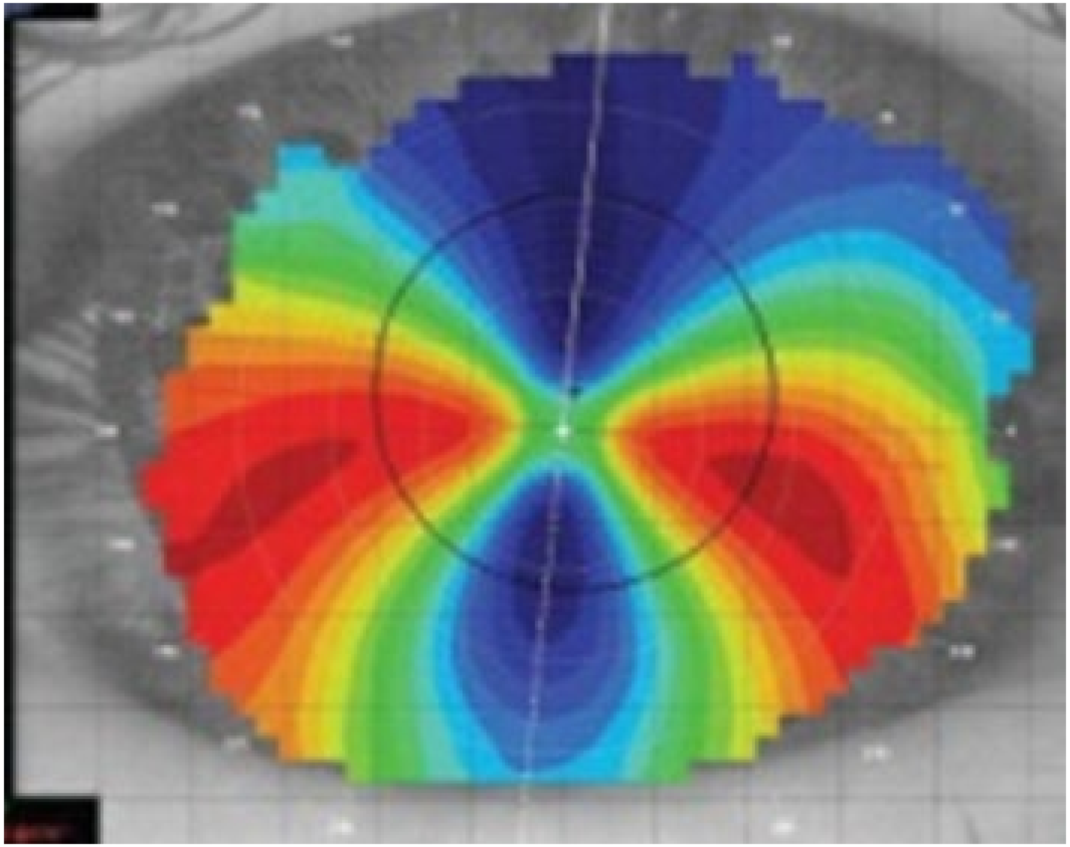
KCN

Refractive Surgery Overview



Topography in KCN: Classic *inferior corneal steepening*

Refractive Surgery Overview



Topography in PMD: Classic *kissing doves*

Refractive Surgery Overview

Corneal Placido-disk topography: Mires typical of keratoconus

Refractive Surgery Overview

Refractive Surgery

Intraocular

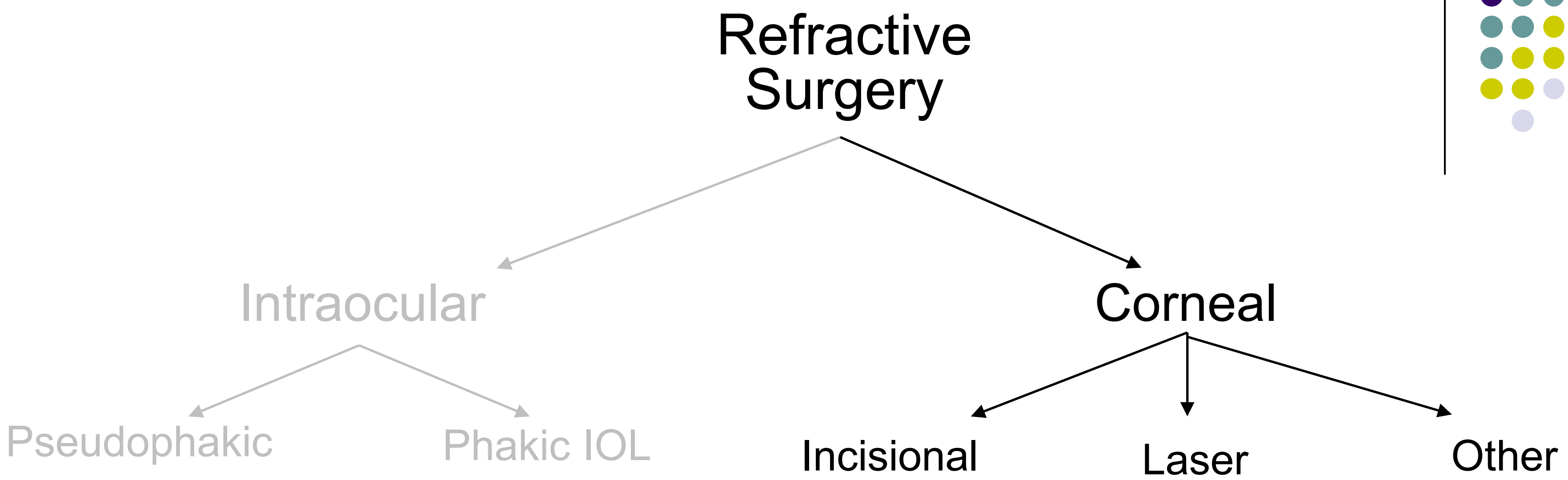
Corneal

Pseudophakic

Phakic IOL

Most *corneal refractive surgeries* involve altering the shape of the cornea in a way that impacts the vergence it imparts to incoming light.

Refractive Surgery Overview



Most *corneal refractive surgeries* involve altering the shape of the cornea in a way that impacts the vergence it imparts to incoming light. These alterations can involve incising the cornea, lasering it, or some other means.

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

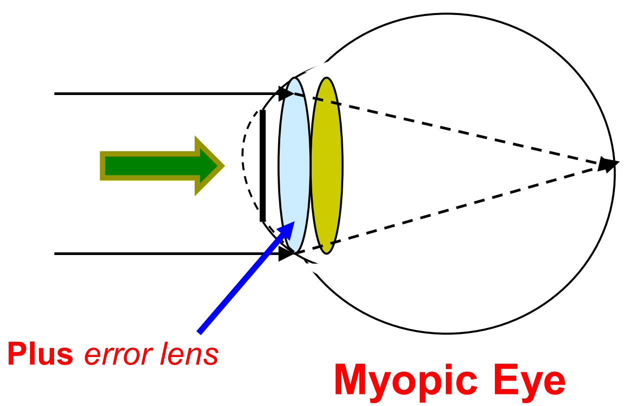
In a *keratoablative laser procedures* (eg, LASIK), the cornea is reshaped so as to offset the effect of the error lens..

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - **Laser**
  - Other

In a *keratoablative laser procedures* (eg, LASIK), the cornea is reshaped so as to offset the effect of the error lens. In **myopic keratoablative surgery**, the central cornea is flattened to reduce its converging power.



Refractive Surgery Overview

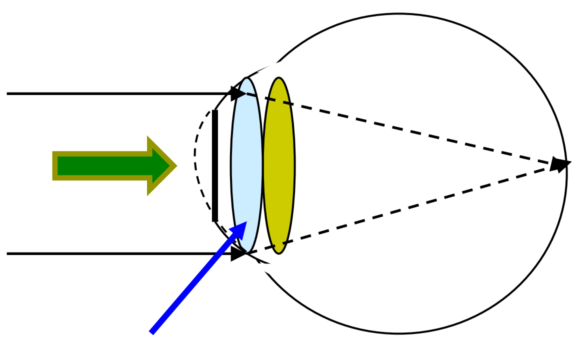
Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - **Laser**
  - Other

Think of it as shaving down the peak of a mountain in order to make the structure more mesa-like

the cornea is reshaped so as to offset the

surgery, **the central cornea is flattened**



Plus *error lens*

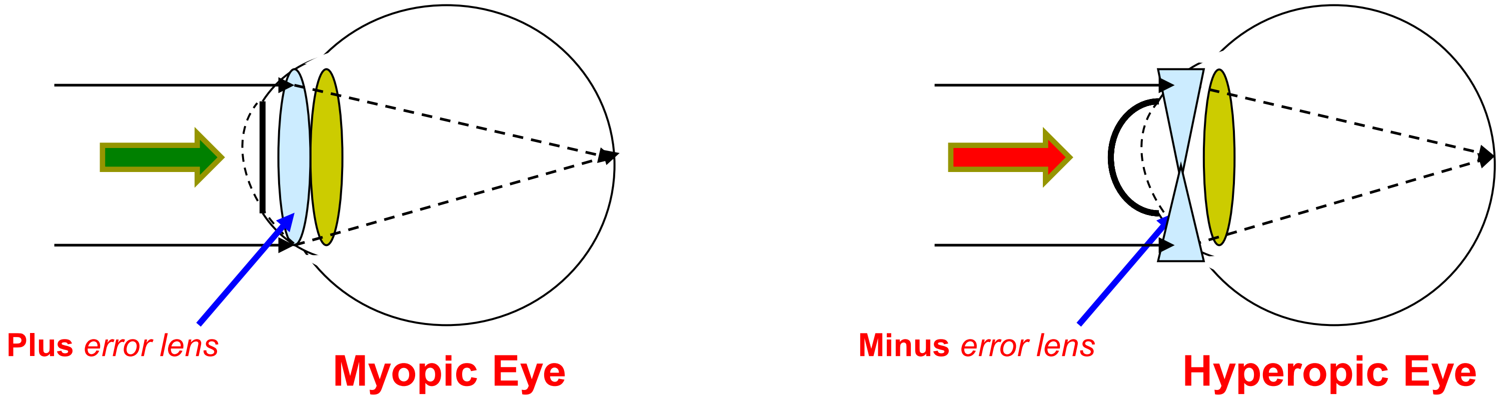
Myopic Eye

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - **Laser**
  - Other

In a *keratoablative laser procedures* (eg, LASIK), the cornea is reshaped so as to offset the effect of the error lens. In **myopic keratoablative surgery**, the central cornea is flattened to reduce its converging power. **Hyperopic keratoablative surgery** is the opposite—the central cornea is *steepened* to *increase* its converging power.



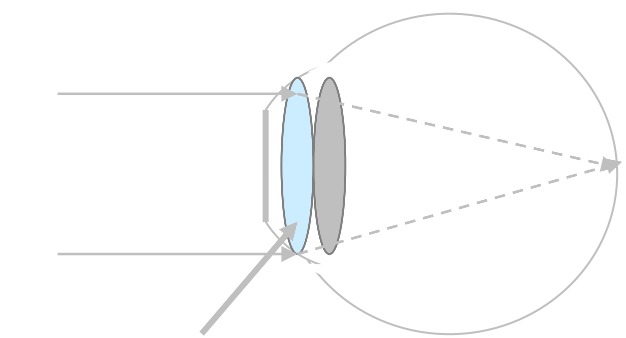
Refractive Surgery Overview

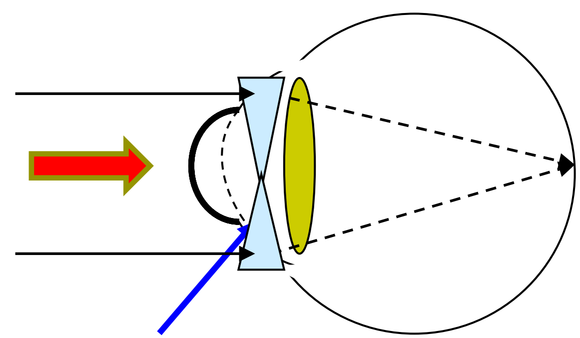
Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - **Laser**
  - Other

In a *keratoablative laser procedures* (eg, L
effect of the error lens. In **myopic keratoa**
to reduce its converging power. **Hyperopic**
the central cornea is *steepened* to *increa*

In contrast, hyperopic keratoablative surgery is akin to shaving down the ***rim of a mesa*** *in order to make its structure more mountain-like*

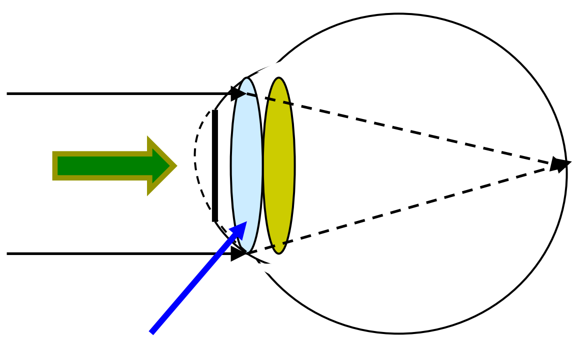




Refractive Surgery Overview

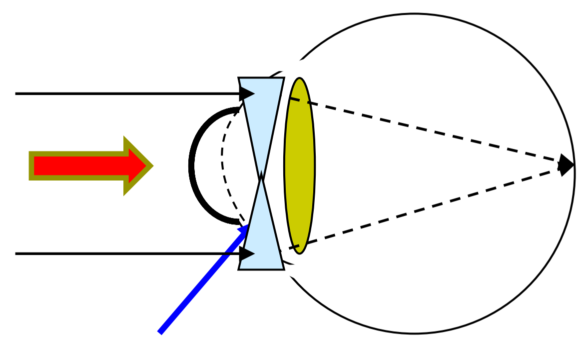
- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
    - **Laser**
    - Other

Note that, by definition, keratoablative refractive surgery involves reshaping the central cornea (and thereby altering its refractive power) via the removal (by annihilation) of corneal tissue



Plus *error lens*

Myopic Eye



Minus *error lens*

Hyperopic Eye

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

*One laser-based keratorefractive procedure does *not* involve tissue annihilation, rather, in it a section of corneal stroma is carved, then removed *en bloc*

Pseudophakic

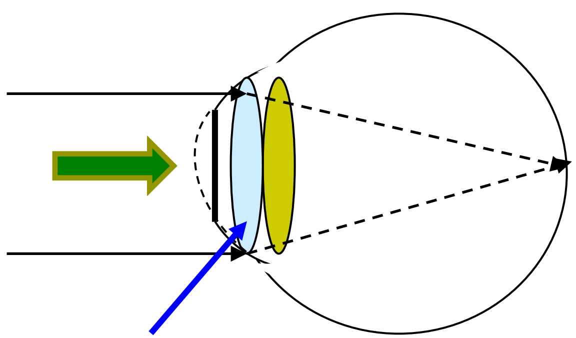
Phakic IOL

Incisional

Laser

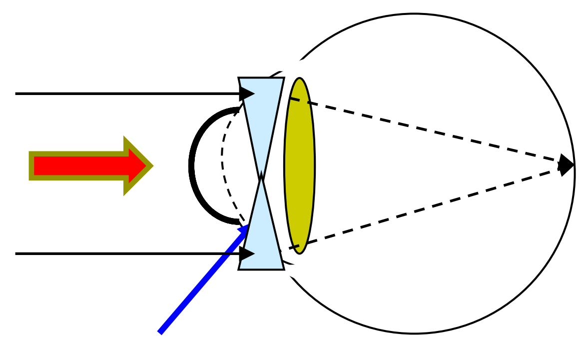
Other

Note that, by definition, keratoablative refractive surgery involves reshaping the central cornea (and thereby altering its refractive power) via **the removal (by annihilation) of corneal tissue***



Plus *error lens*

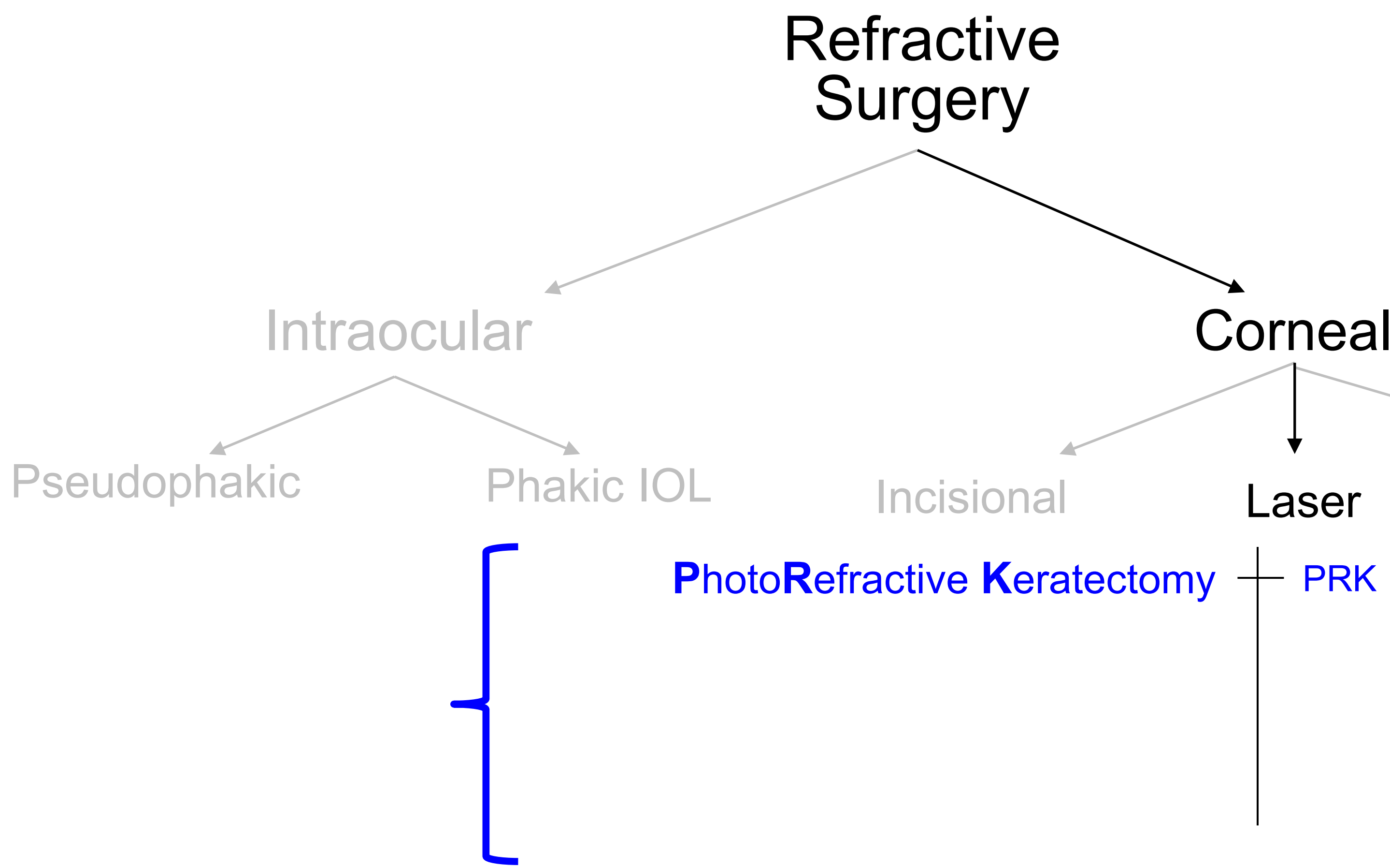
Myopic Eye



Minus *error lens*

Hyperopic Eye

Refractive Surgery Overview



These are the *laser-based keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - Laser
  - Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
  - Laser
  - Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
    - Laser
    - Other

Photo**R**efractive **K**eratectomy — PRK
LASer Sub**E**pithelial **K**eratomileusis — LASEK
Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK
LASer **I**n-situ **K**eratomileusis — LASIK

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

Intraocular

Pseudophakic

Phakic IOL

Corneal

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy	PRK
LASer Sub**E**pithelial **K**eratomileusis	LASEK
Epipolis **LAS**er **I**n-situ **K**eratomileusis	Epi-LASIK
LASer **I**n-situ **K**eratomileusis	LASIK
SMall-**I**ncision **L**enticule **E**xtraction	SMILE

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

LASer **I**n-situ **K**eratomileusis — LASIK

SMall-**I**ncision **L**enticule **E**xtraction — SMILE

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book. All are ablative except for *SMILE*, which is the nonablative one referred to on a recent slide.

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

In the SMILE procedure, the femtosecond laser, with its ability to be focused at very precise depths within the cornea, is used to carve a segment (called a *lenticule*) of very specific shape within the stroma without disturbing the overlying or underlying tissue.

SMall-**I**ncision **L**enticule **E**xtraction — SMILE

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book. All are ablative except for ***SMILE***, which is the nonablative one referred to on a recent slide.

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

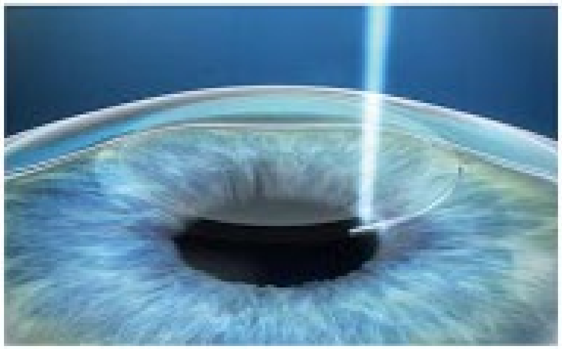
Other

In the SMILE procedure, the femtosecond laser, with its ability to be focused at very precise depths within the cornea, is used to carve a segment (called a *lenticule*) of very specific shape within the stroma without disturbing the overlying or underlying tissue. The lenticule is then removed *en bloc* by being extracted through a very small incision (also created by the femto) that connects the femto-created intrastromal space and the corneal surface.

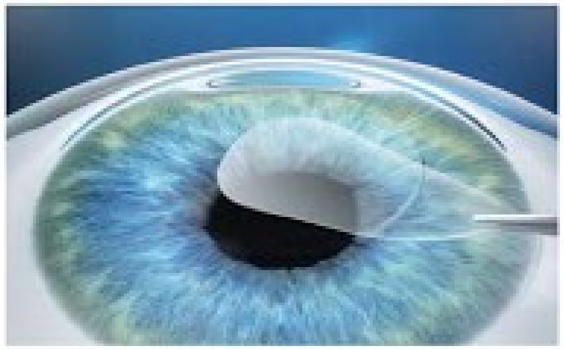
SMall-**I**ncision **L**enticule **E**xtraction — SMILE

These are the *laser-based keratorefractive procedures* covered in the *BCSC* book. All are ablative except for ***SMILE***, which is the nonablative one referred to on a recent slide.

Refractive Surgery Overview



Creation of lenticule and small access (< 4 mm)



Removal of the lenticule

Refractive error is corrected

SMILE

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

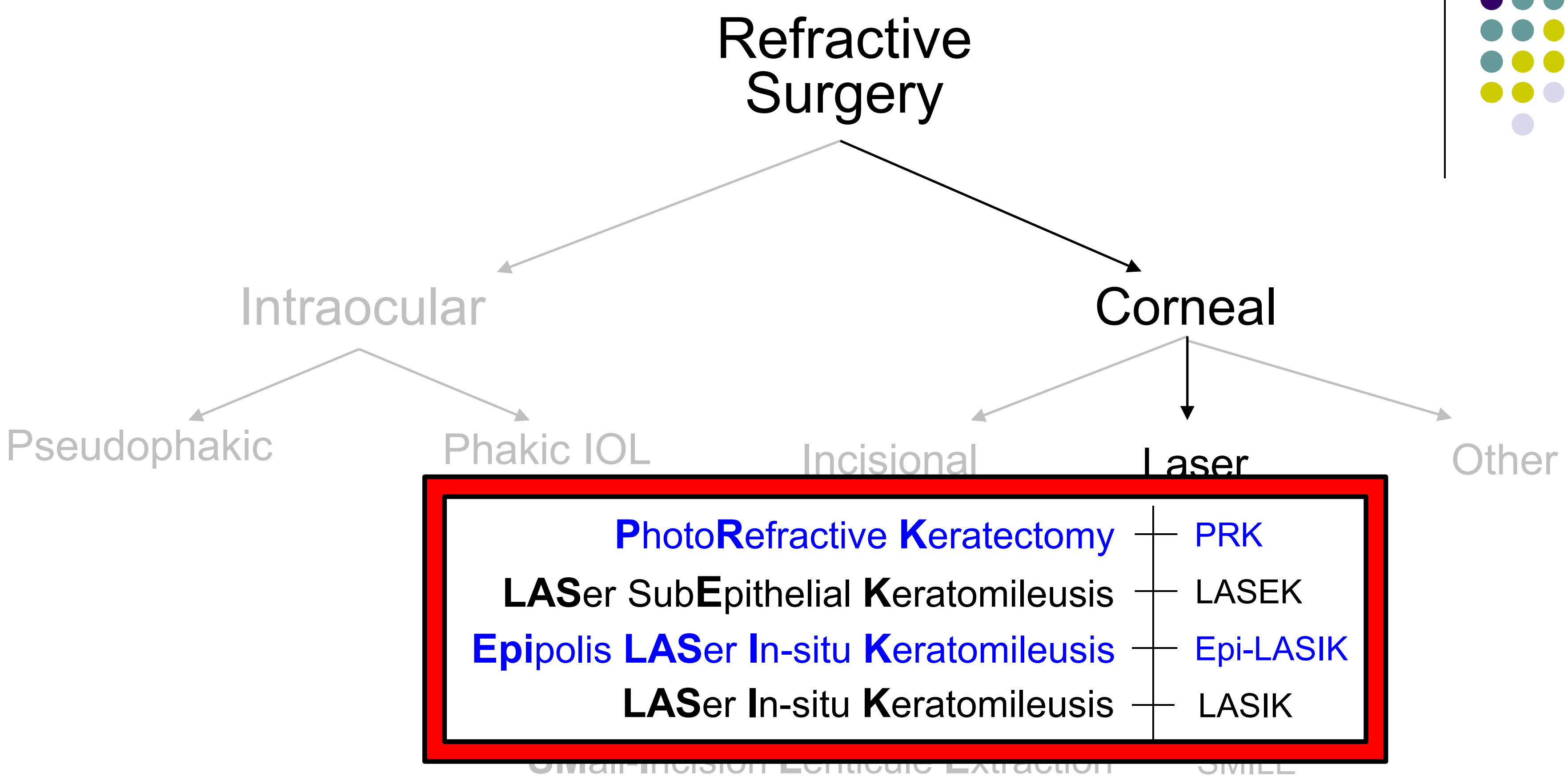
Other

In the SMILE procedure, the femtosecond laser, with its ability to be focused at very precise depths within the cornea, is used to carve a segment (called a *lenticule*) of very specific shape within the stroma without disturbing the overlying or underlying tissue. The lenticule is then removed *en bloc* by being extracted through a very small incision (also created by the femto) that connects the femto-created intrastromal space and the corneal surface. The resulting loss of tissue reshapes the central corneal surface in a way that produces a desired change in its refractive power.

SMall-**I**ncision **L**enticule **E**xtraction — SMILE

These are the laser-*based keratorefractive procedures* covered in the *BCSC* book. All are ablative except for ***SMILE***, which is the nonablative one referred to on a recent slide.

Refractive Surgery Overview



In **keratoablative procedures**, remodeling of the central cornea occurs via annihilation of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way.

Refractive Surgery Overview

Refractive Surgery

Intraocular
- Pseudophakic
- Phakic IOL

Corneal
- Incisional
- Laser
- Other

Photo**R**efractive **K**eratectomy	PRK
LASer Sub**E**pithelial **K**eratomileusis	LASEK
Epipolis **LAS**er **I**n-situ **K**eratomileusis	Epi-LASIK
LASer **I**n-situ **K**eratomileusis	LASIK

In **keratoablative procedures**, remodeling of the central cornea occurs via annihilation of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

In **PRK**, the handling of the epithelium couldn't be more straightforward. It is simply cast aside—via scraping, chemical destruction, brushing, lasing, etc. This makes PRK the simplest of the laser keratorablative procedures: get the epithelium out of the way, then forget about it.

In **keratoablative procedures**, remodeling of the central cornea occurs via annihilation of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

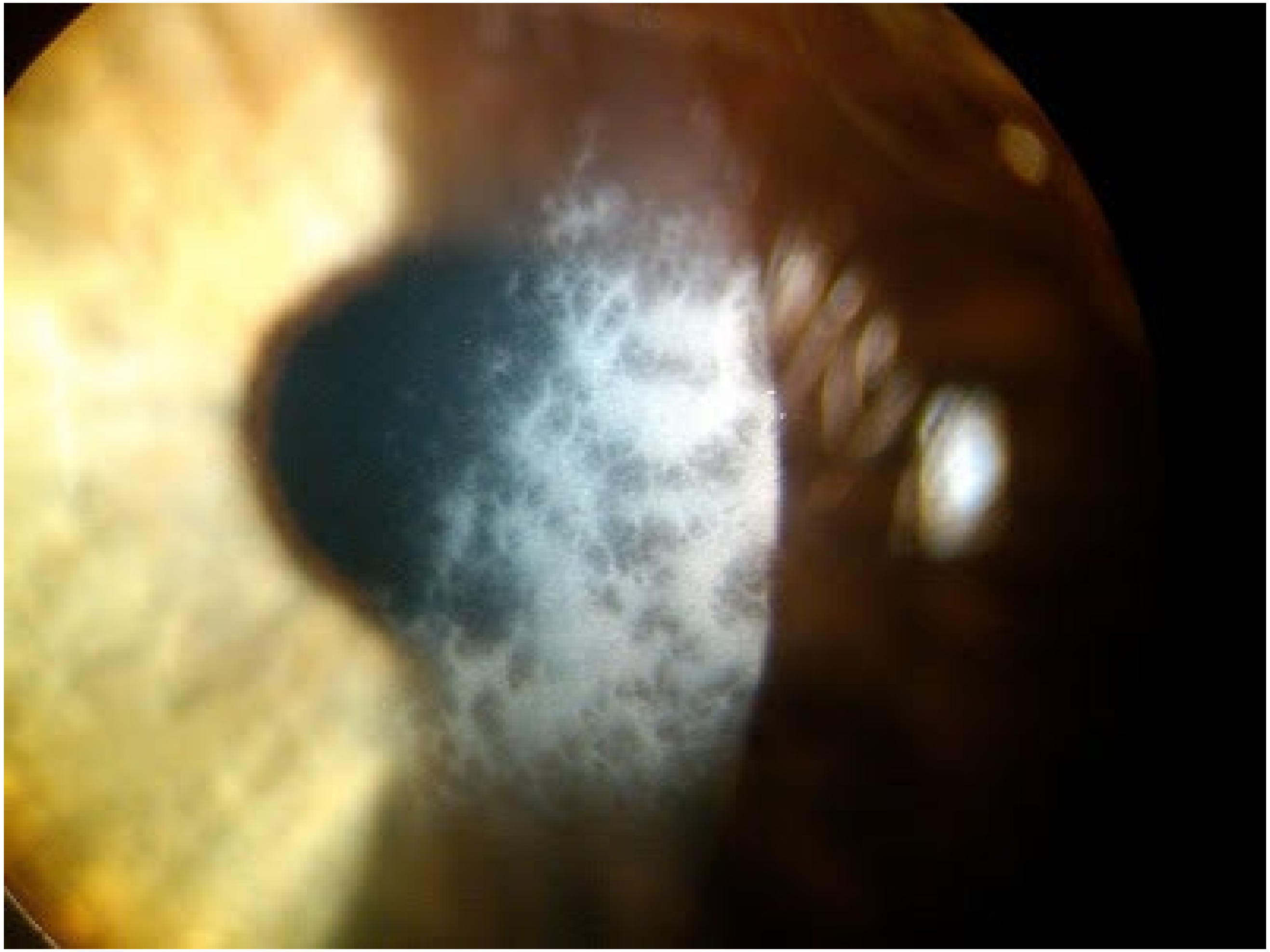
Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

In **PRK**, the handling of the epithelium couldn't be more straightforward. It is simply cast aside—via scraping, chemical destruction, brushing, lasing, etc. This makes PRK the simplest of the laser keratorablative procedures: get the epithelium out of the way, then forget about it. However, PRK is associated with several post-operative complications that render it problematic, two of which are 1) it produces significant post-op pain, and 2) it is associated with an increased risk of post-op haze formation—a potentially sight-threatening development.

In **keratoablative procedures**, remodeling of the central cornea occurs via annihilation of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview



Post-PRK haze

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
    - Laser
      - **P**hoto**R**efractive **K**eratectomy — PRK
      - **LAS**er Sub**E**pithelial **K**eratomileusis — LASEK
      - **Epi**polis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK
      - **LAS**er **I**n-situ **K**eratomileusis — LASIK
    - Other

In contrast, the well-known **LASIK** procedure deals with the epithelium by doing an end-run around it.

In

of t

the corneal epithelium has to get out of the way. *[The four keratoablative procedures differ solely in how the epithelium is handled.]*

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

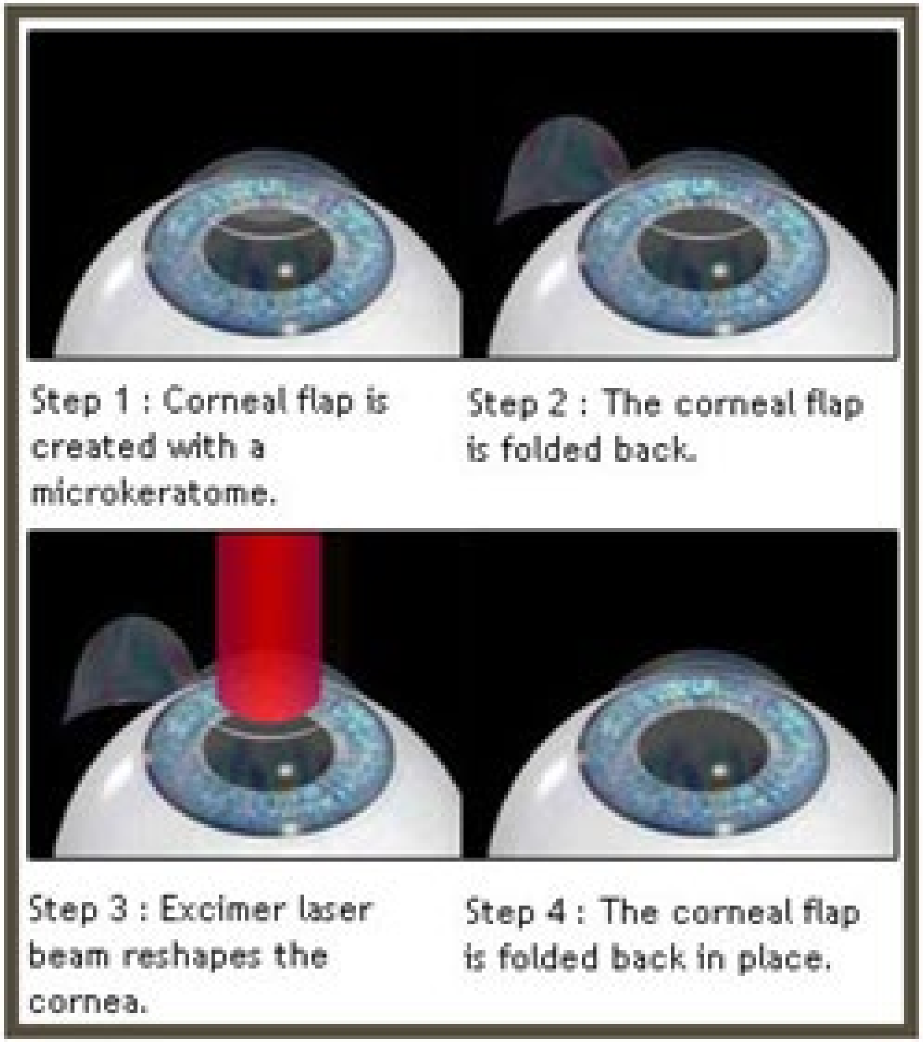
LASer **I**n-situ **K**eratomileusis — LASIK

SMall **I**ncision **L**enticule **E**xtraction — SMILE

In contrast, the well-known **LASIK** procedure deals with the epithelium by doing an end-run around it. A hinged flap is cut in the stroma and reflected, thereby moving the overlying 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. Far less pain; vastly reduced risk of haze formation.

In ... of t ... the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview



LASIK

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
    - Laser
    - Other

- **P**hoto**R**efractive **K**eratectomy — PRK
- **LAS**er Sub**E**pithelial **K**eratomileusis — LASEK
- **Epi**polis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

Like PRK, LAS**E**K is a 'surface ablation' procedure. However, it deals very differently with the corneal epithelium.

In k
of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

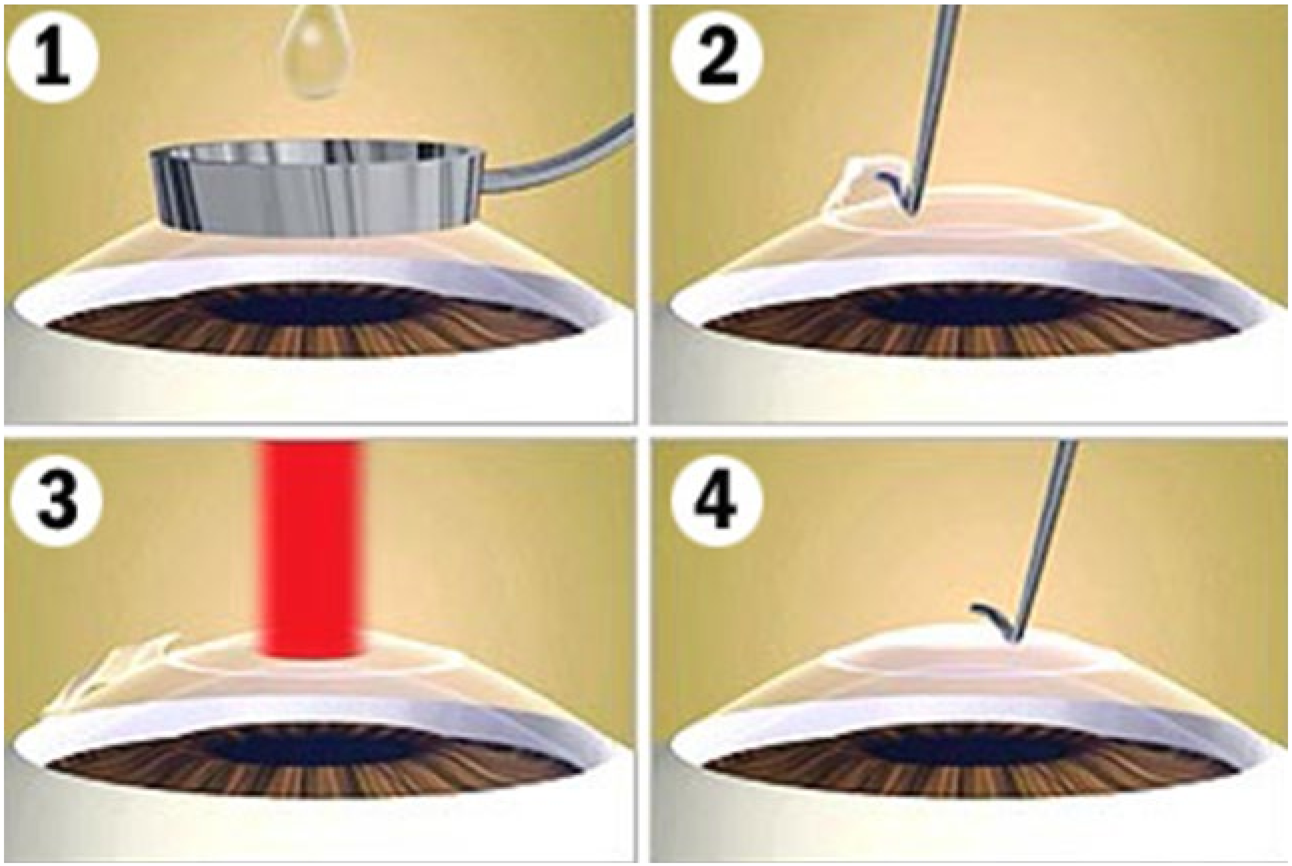
Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

Like PRK, LAS**E**K is a 'surface ablation' procedure. However, it deals very differently with the corneal epithelium. In LASEK, the epithelium is chemically devitalized and loosened by bathing it in an alcohol solution. The loosened epithelium is then folded back, and the ablation is performed. Following the ablation, this 'epithelial flap' is smoothed back into place and covered with a bandage CL.

In k… of t…

the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview



LASEK

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Photo**R**efractive **K**eratectomy — PRK

LASer Sub**E**pithelial **K**eratomileusis — LASEK

Epipolis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK

Like PRK, LAS**E**K is a 'surface ablation' procedure. However, it deals very differently with the corneal epithelium. In LASEK, the epithelium is chemically devitalized and loosened by bathing it in an alcohol solution. The loosened epithelium is then folded back, and the ablation is performed. Following the ablation, this 'epithelial flap' is smoothed back into place and covered with a bandage CL. By re-positing the epithelium, LASEK avoids the large epi defect (and resulting severe pain) of PRK.

In k… of t… the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview

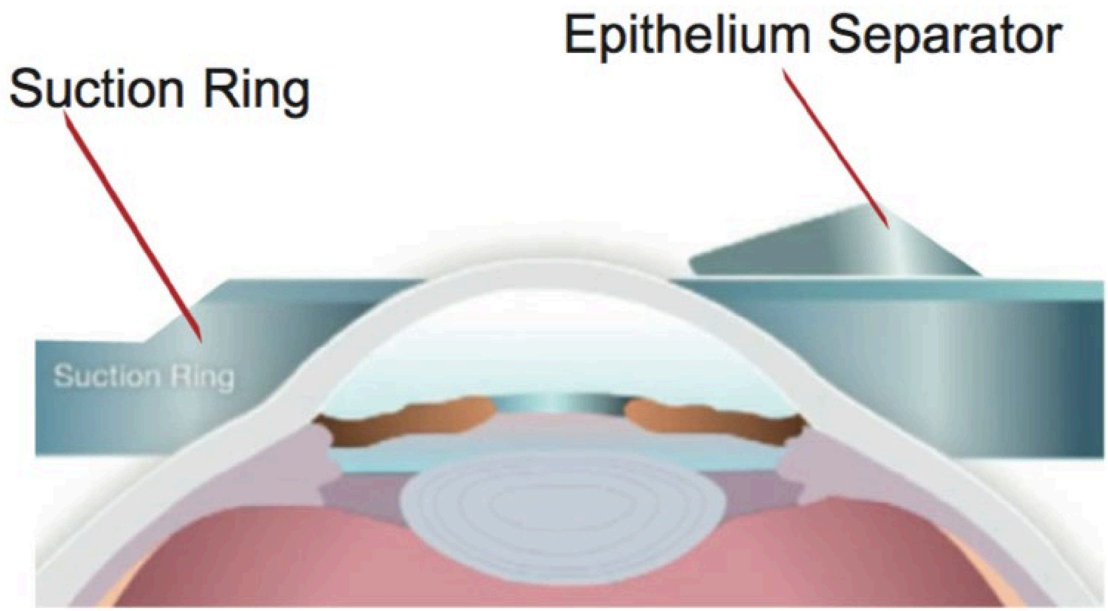
- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
    - Laser
      - **P**hoto**R**efractive **K**eratectomy — PRK
      - **LAS**er Sub**E**pithelial **K**eratomileusis — LASEK
      - **Epi**polis **LAS**er **I**n-situ **K**eratomileusis — Epi-LASIK
      - **LAS**er **I**n-situ **K**eratomileusis — LASIK
    - Other

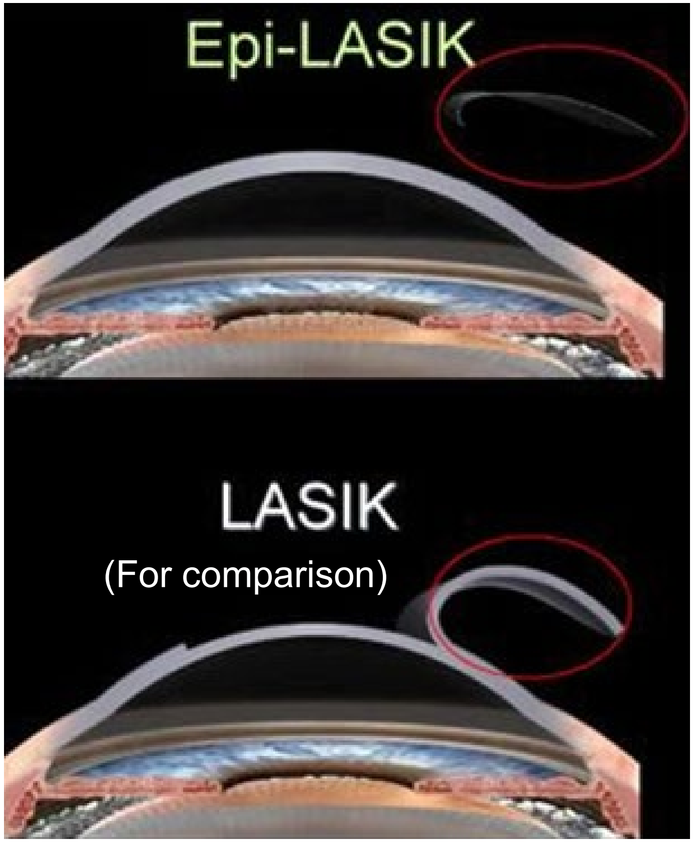
Like LASEK, **epi-LASIK** is a surface-ablation variant designed to avoid the drawbacks of PRK. In it, a blunt keratome (an ‘epikeratome’) slides under the epithelium, separating it.

In

of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview





Epi-LASIK

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

PhotoRefractive Keratectomy — PRK

LASer SubEpithelial Keratomileusis — LASEK

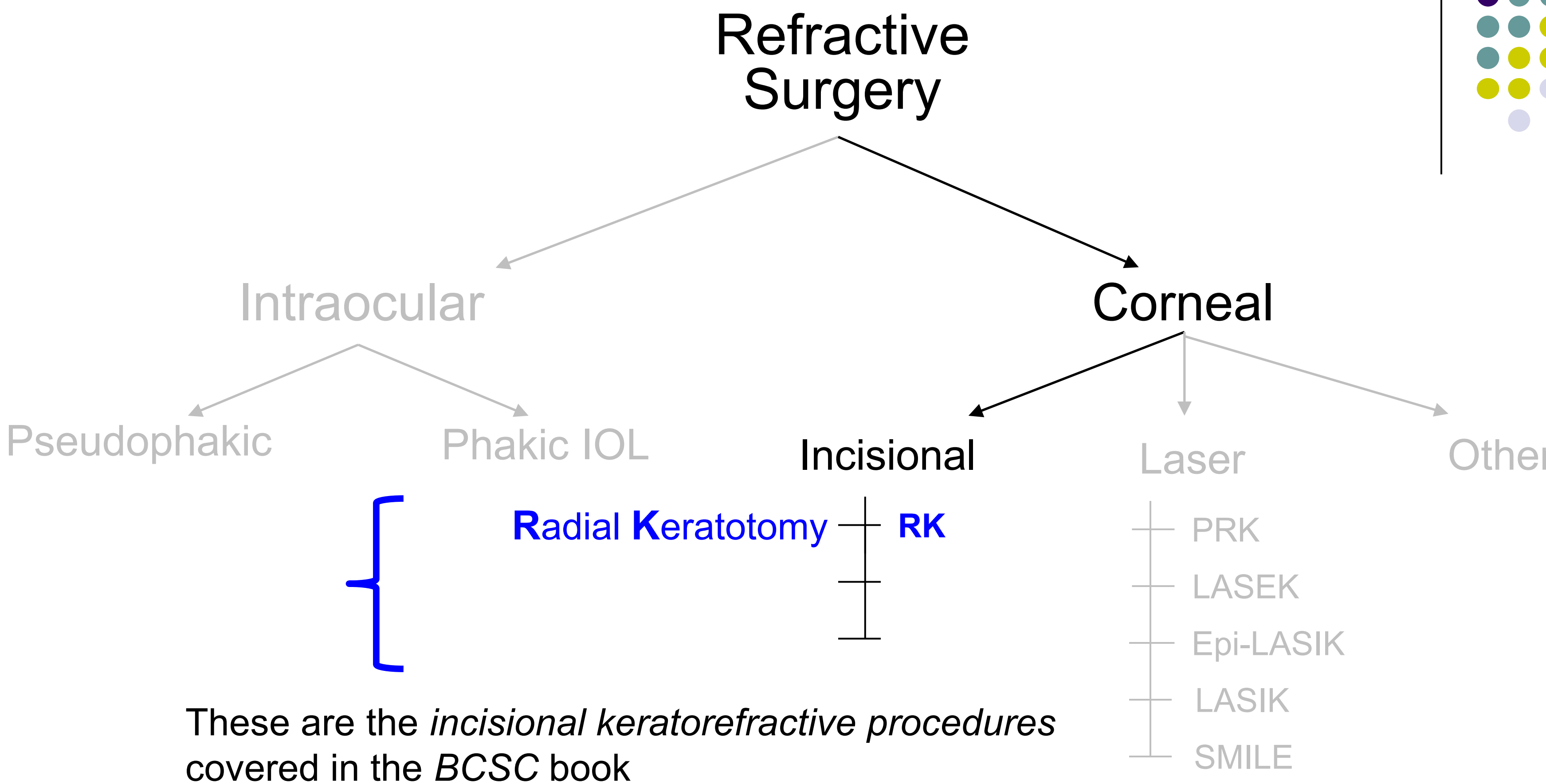
Epipolis **LAS**er **In**-situ **K**eratomileusis — Epi-LASIK

LASer In-situ Keratomileusis — LASIK

Like LASEK, **epi-LASIK** is a surface-ablation variant designed to avoid the drawbacks of PRK. In it, a blunt keratome (an ‘epikeratome’) slides under the epithelium, separating it. The epithelial flap thus created is folded back, then re-placed after the stroma has been ablated. (BTW, *epipolis* is a Greek word meaning ‘superficial.’)

In [illegible] of the corneal stroma with an excimer laser. But before the excimer can get to the stroma, the corneal epithelium has to get out of the way. *The four keratoablative procedures differ solely in how the epithelium is handled.*

Refractive Surgery Overview



These are the *incisional keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
      - **R**adial **K**eratotomy — **RK**
      - **A**rcuate **K**eratotomy — **AK**
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other

These are the *incisional keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
      - **R**adial **K**eratotomy — **RK**
      - **A**rcuate **K**eratotomy — **AK**
      - **L**imbal **R**elaxing **I**ncisions — **LRI**
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other

These are the *incisional keratorefractive procedures* covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

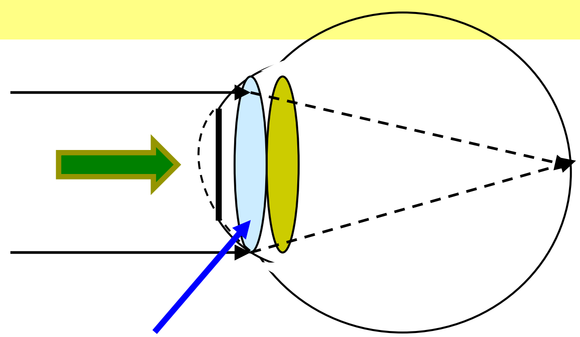
Laser

Other

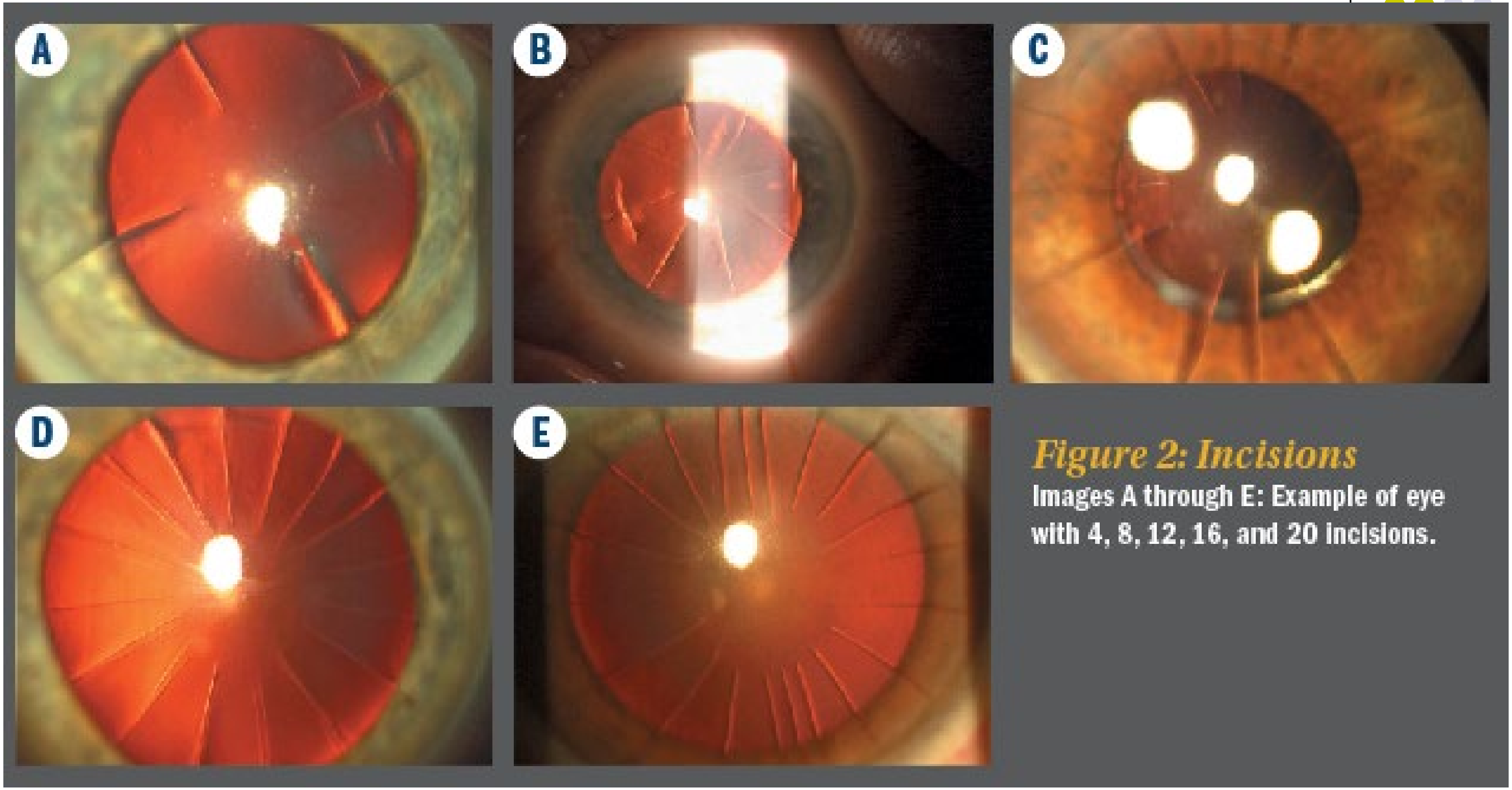
Radial **K**eratotomy — **RK**

PRK

A set of incisions oriented radially (**radial keratotomy**, RK) will flatten the central cornea, and thereby reduce its converging power. Thus, RK can be used to treat myopia.



Refractive Surgery Overview



Radial keratotomy

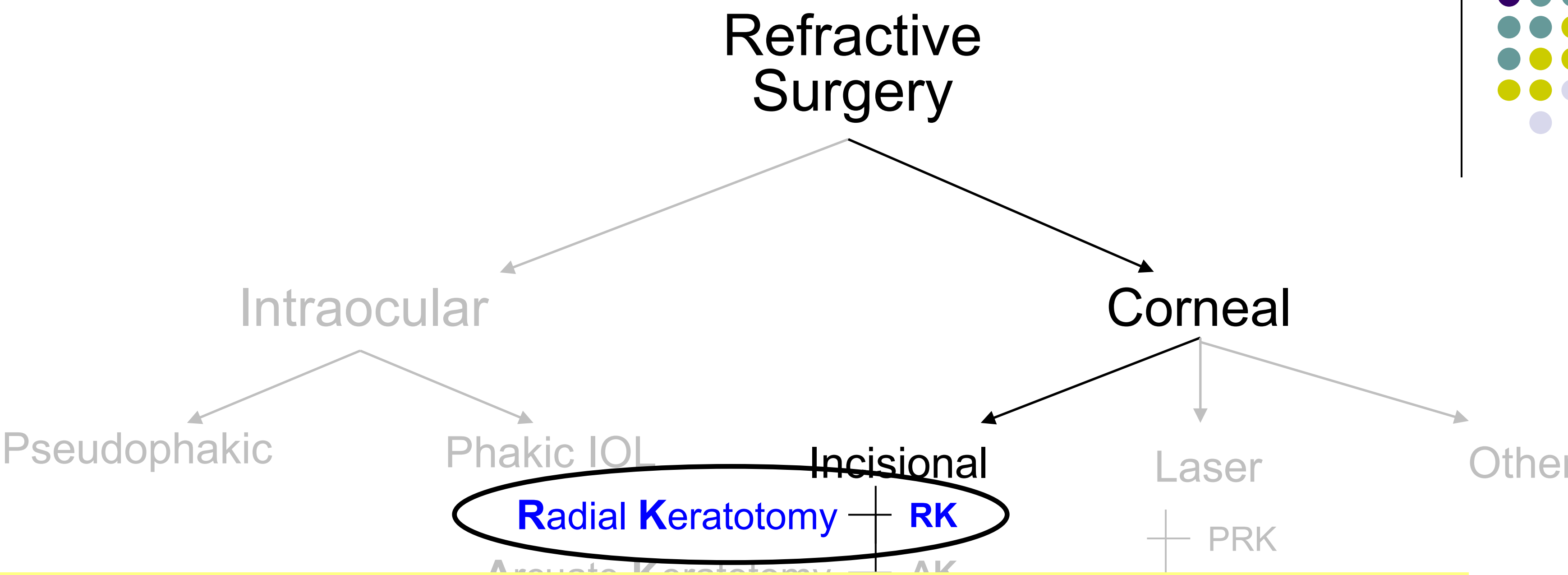
Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - **R**adial **K**eratotomy — **RK**
  - Laser
    - PRK
  - Other

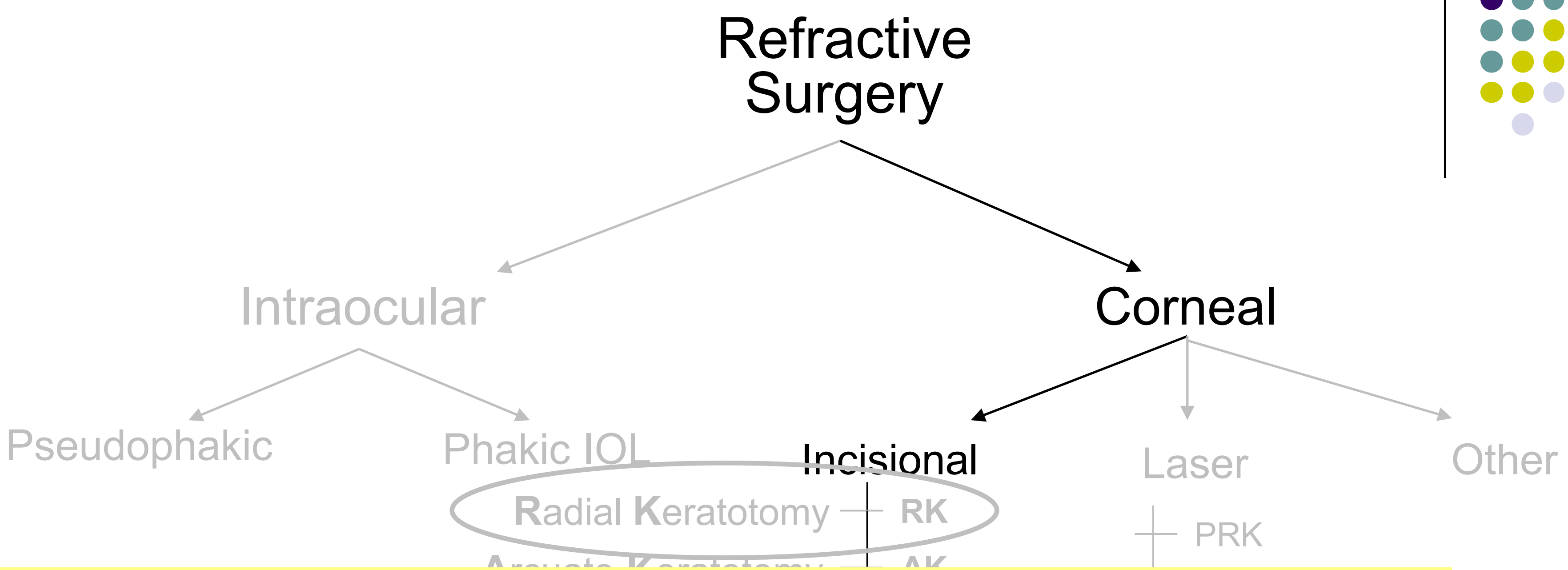
A set of incisions oriented radially (**radial keratotomy**, RK) will flatten the central cornea, and thereby reduce its converging power. Thus, RK can be used to treat myopia. Note that because incisions cannot produce overall *steepening* of the central cornea, RK cannot be used to treat hyperopia.

Refractive Surgery Overview



A set of incisions oriented radially (**radial keratotomy**, RK) will flatten the central cornea, and thereby reduce its converging power. Thus, RK can be used to treat myopia. Note that because incisions cannot produce overall *steepening* of the central cornea, RK cannot be used to treat hyperopia. Note also that, at this juncture, RK is considered obsolete, and is thus no longer performed in the US.

Refractive Surgery Overview



A set of incisions oriented radially (**radial keratotomy**, RK) will flatten the central cornea, and thereby reduce its converging power. Thus, RK can be used to treat myopia. Note that because incisions cannot produce overall *steepening* of the central cornea, RK cannot be used to treat hyperopia. Note also that, at this juncture, **RK is considered obsolete, and is thus no longer performed in the US.**

OTOH, *peripheral* incisional procedures to offset *astigmatic* refractive error are an important and oft-used surgical technique

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - Radial Keratotomy — RK
    - **A**rcuate **K**eratotomy — **AK**
    - **L**imbal **R**elaxing **I**ncisions — **LRI**
  - Laser
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
    - SMILE
  - Other

Specifically, this refers to **AK** and **LRI**

OTOH, *peripheral* incisional procedures to offset *astigmatic* refractive error are an important and oft-used surgical technique

Refractive Surgery Overview

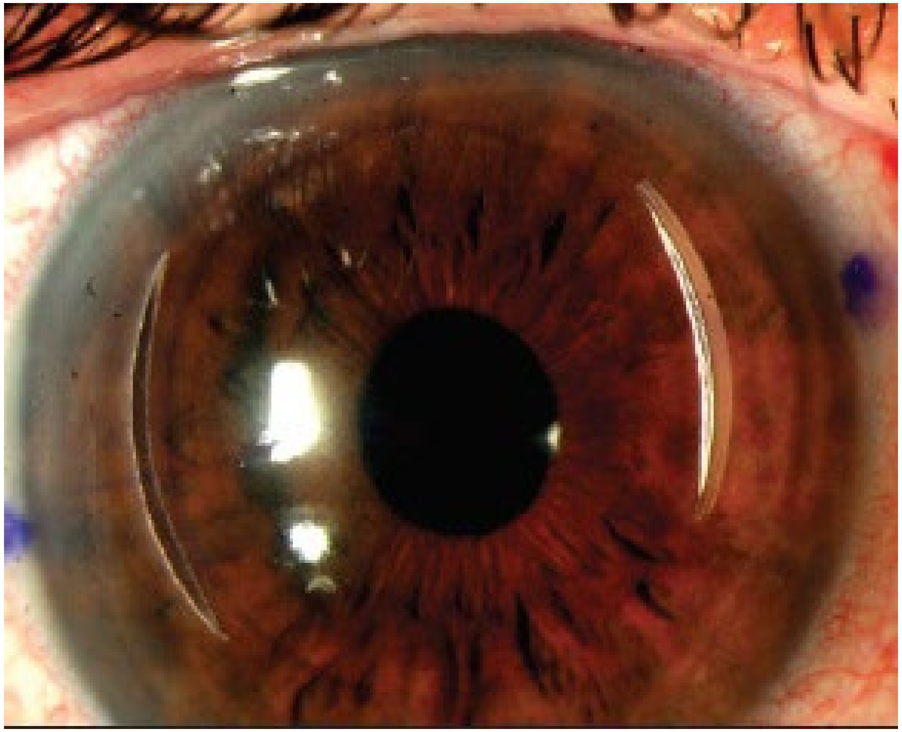
Refractive Surgery

Intraocular
- Pseudophakic
- Phakic IOL

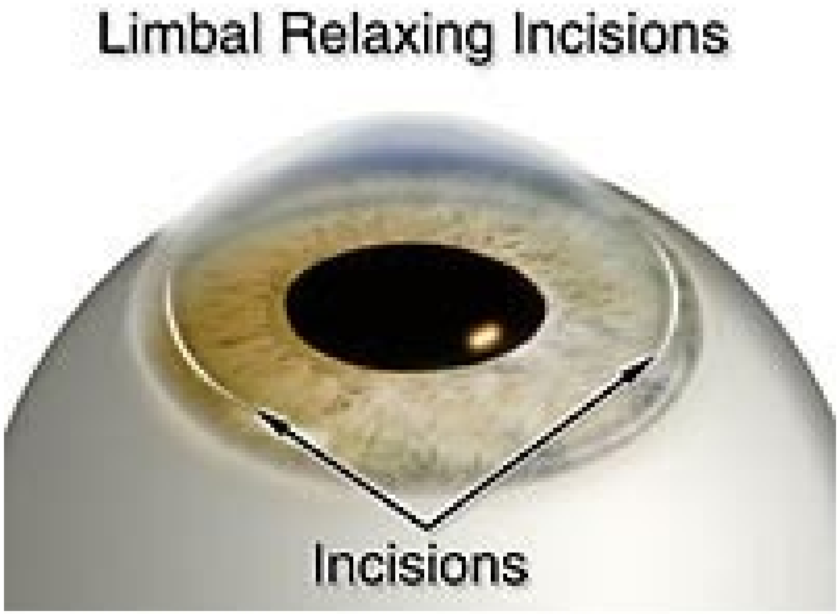
Corneal
- Incisional
  - Radial Keratotomy — RK
  - **A**rcuate **K**eratotomy — **AK**
  - **L**imbal **R**elaxing **I**ncisions — **LRI**
- Laser
  - PRK
  - LASEK
  - Epi-LASIK
  - LASIK
- Other

Both AK and LRI incisions are placed on the steep meridian of the cornea, in pairs located on opposite sides of the cornea. AK incisions are made in the paracentral cornea, whereas LRI are made at the limbus (as their name implies).

Refractive Surgery Overview



AK incisions



LR incisions

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Radial Keratotomy — RK

Arcuate **K**eratotomy — **AK**

Limbal **R**elaxing **I**ncisions — **LRI**

PRK

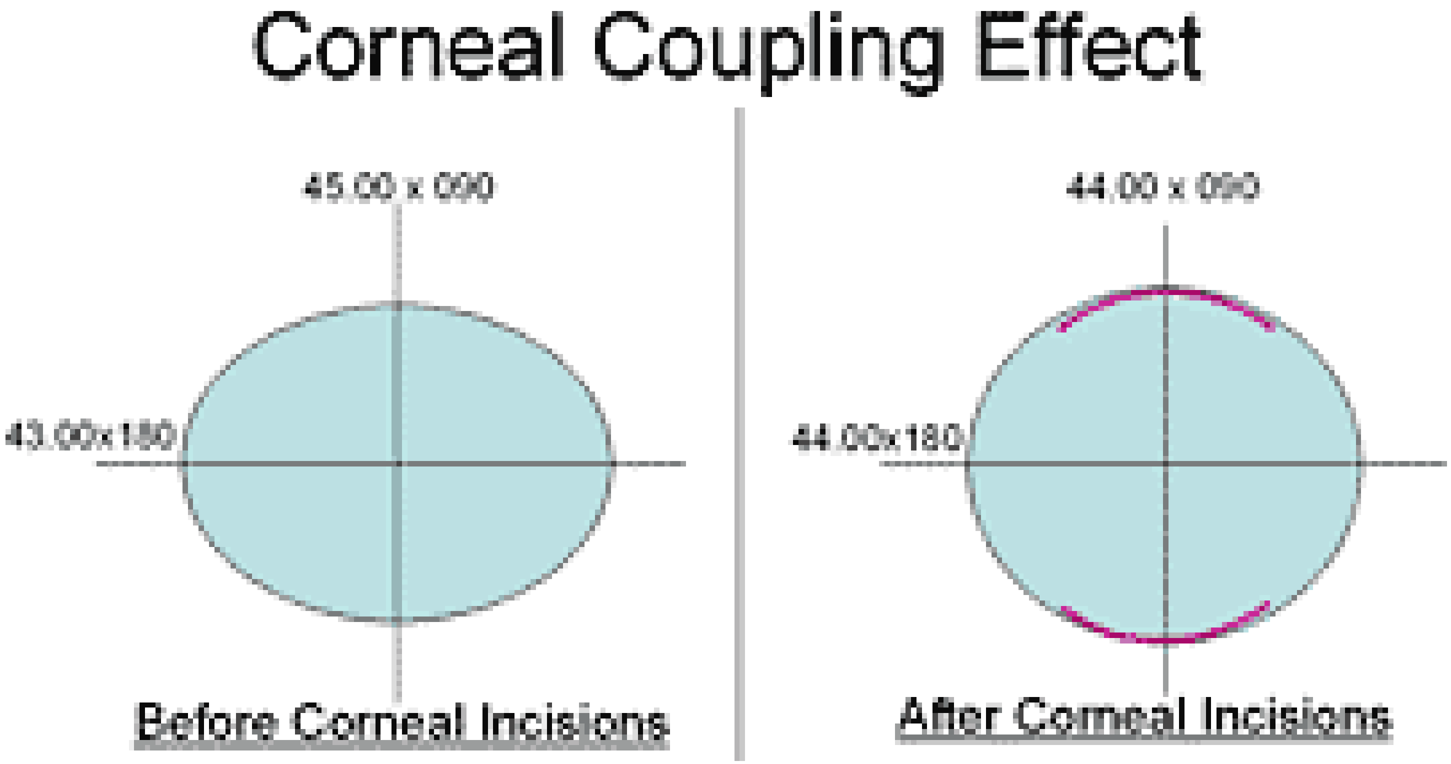
LASEK

Epi-LASIK

LASIK

Both AK and LRI incisions are placed on the steep meridian of the cornea, in pairs located on opposite sides of the cornea. AK incisions are made in the paracentral cornea, whereas LRI are made at the limbus (as their name implies). Both techniques have the effect of flattening the meridian in which they're placed, but through a process called *coupling,* steepening the meridian 90 deg away.

Refractive Surgery Overview



Coupling

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

Phakic IOL

Incisional

Laser

Other

Radial Keratotomy — RK

Arcuate **K**eratotomy — **AK**

Limbal **R**elaxing **I**ncisions — **LRI**

PRK

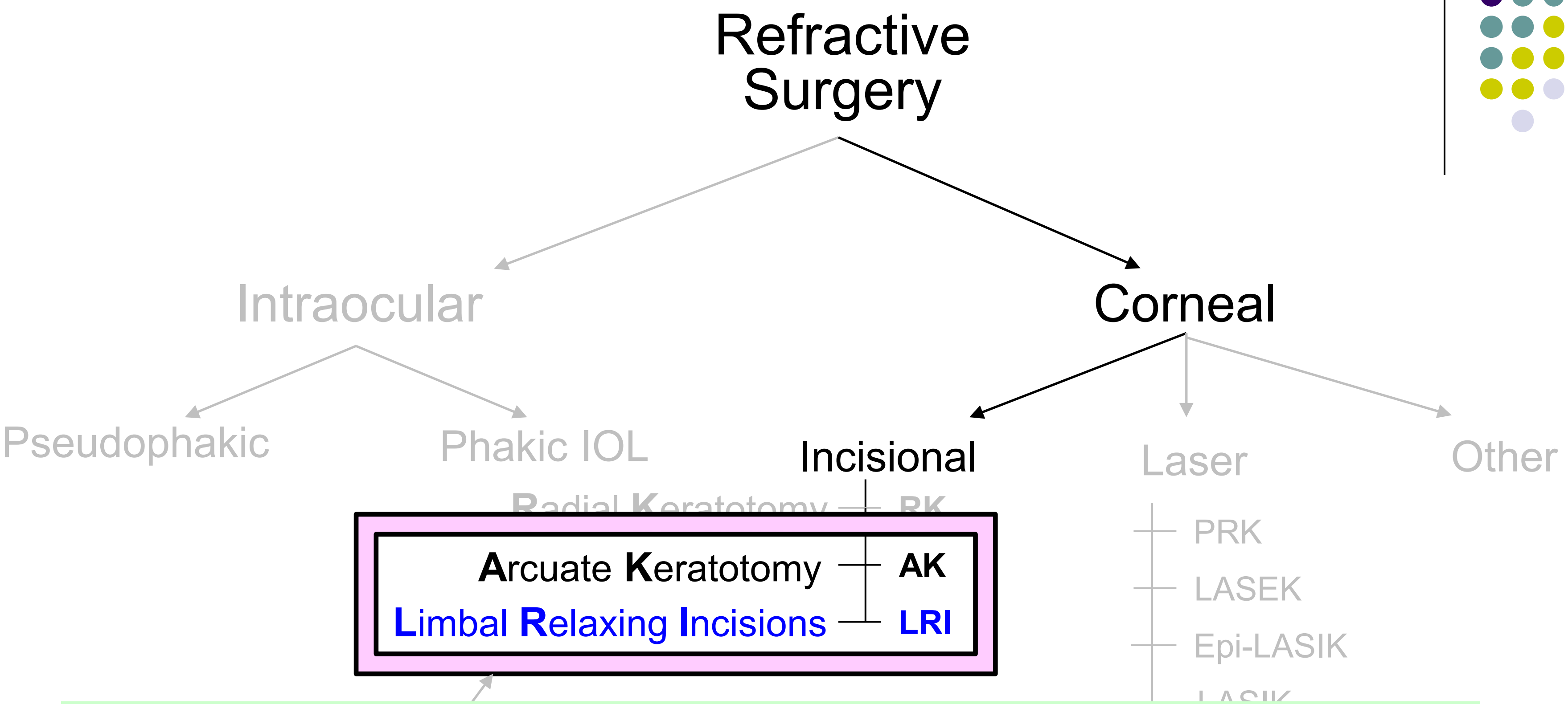
LASEK

Epi-LASIK

LASIK

Both AK and LRI incisions are placed on the steep meridian of the cornea, in pairs located on opposite sides of the cornea. AK incisions are made in the paracentral cornea, whereas LRI are made at the limbus (as their name implies). Both techniques have the effect of flattening the meridian in which they're placed, but through a process called *coupling*, steepening the meridian 90 deg away. The most common indication for AK is correction of astigmatism in an eye that is s/p penetrating keratoplasty.

Refractive Surgery Overview



Both AK and LRI incisions are placed on the steep meridian of the cornea, in pairs located on opposite sides of the cornea. AK incisions are made in the paracentral cornea, whereas LRI are made at the limbus (as their name implies). Both techniques have the effect of flattening the meridian in which they're placed, but through a process called *coupling*, steepening the meridian 90 deg away. The most common indication for AK is correction of astigmatism in an eye that is s/p penetrating keratoplasty. LRI are typically placed at the time of cataract surgery to correct corneal astigmatism in hopes of producing better UCVA post-op.

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - RK
    - AK
    - LRI
  - Laser
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
    - SMILE
  - Other
    - **C**onductive **K**eratoplasty — ***CK***

These are the ‘other’ procedures covered in the *BCSC* book

Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - RK
    - AK
    - LRI
  - Laser
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
    - SMILE
  - Other
    - **C**onductive **K**eratoplasty — ***CK***
    - **S**mall **A**perture **I**nlay — ***SAI***

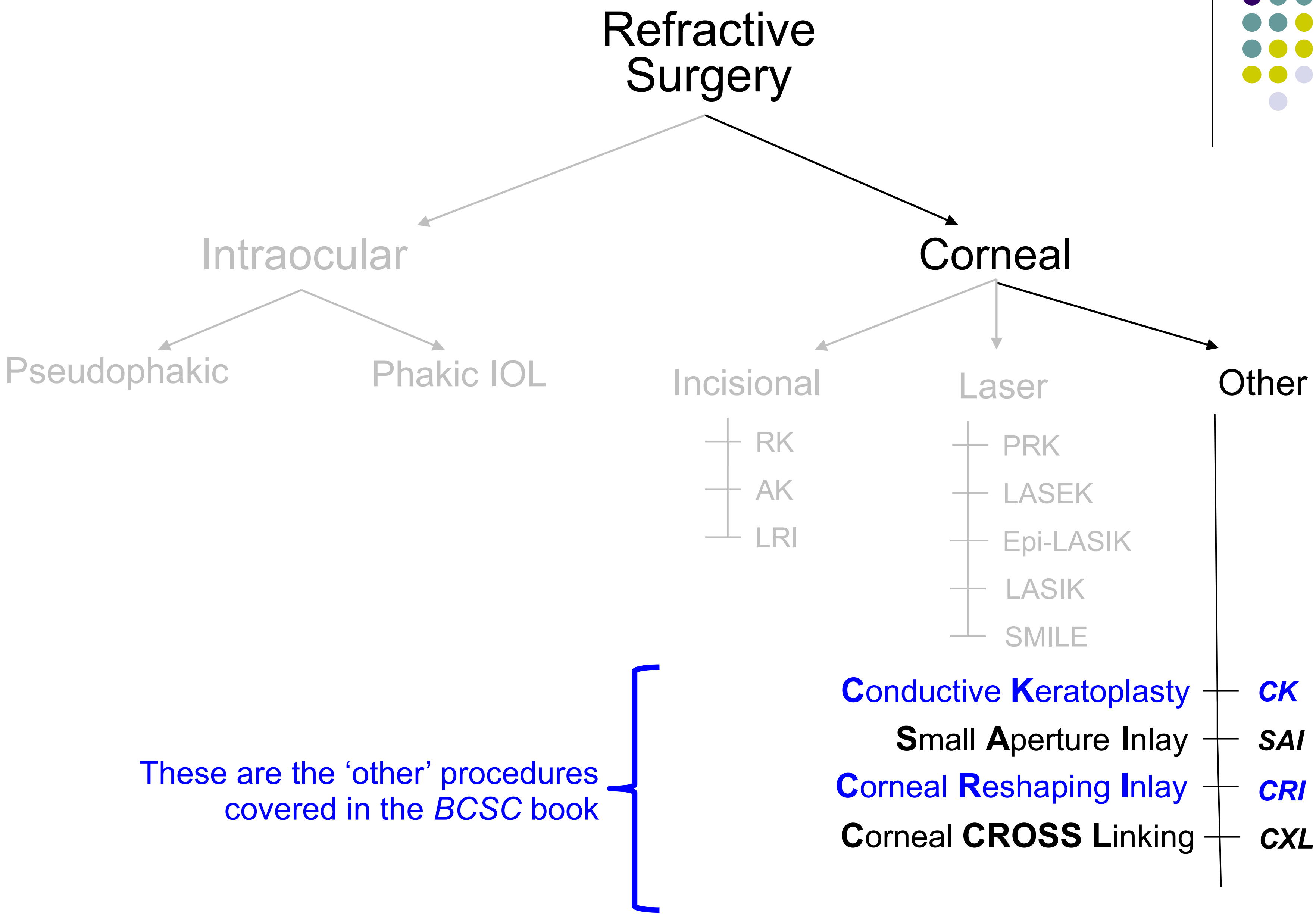
These are the ‘other’ procedures covered in the *BCSC* book

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
      - RK
      - AK
      - LRI
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other
      - **C**onductive **K**eratoplasty — ***CK***
      - **S**mall **A**perture **I**nlay — ***SAI***
      - **C**orneal **R**eshaping **I**nlay — ***CRI***

These are the 'other' procedures covered in the *BCSC* book

Refractive Surgery Overview



Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
      - RK
      - AK
      - LRI
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other
      - **C**onductive **K**eratoplasty — ***CK***
      - **S**mall **A**perture **I**nlay — ***SAI***
      - **C**orneal **R**eshaping **I**nlay — ***CRI***
      - Corneal **CROSS L**inking — ***CXL***
      - **I**ntrastromal **C**orneal **R**ing **S**egments — ***ICRS***

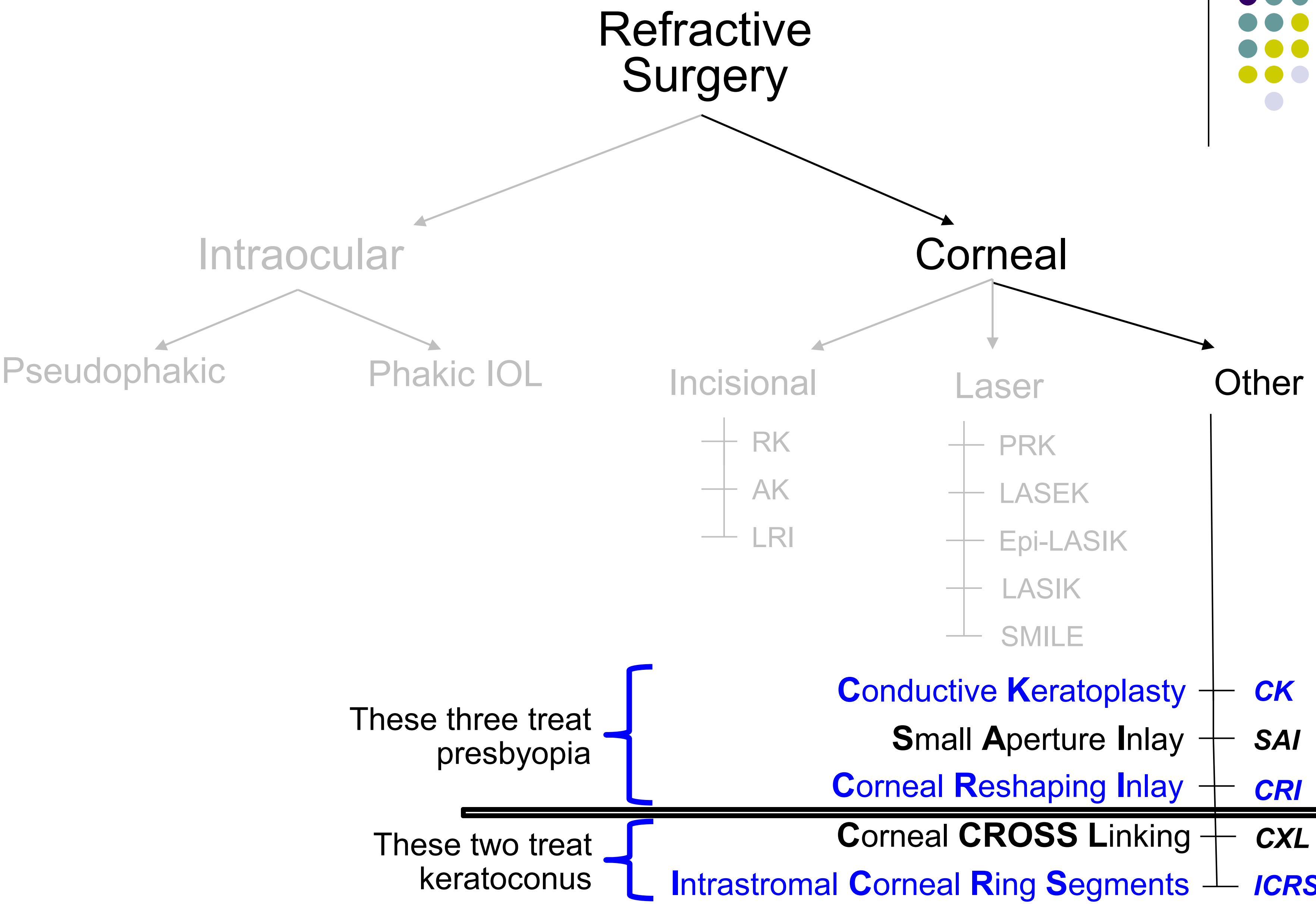
These are the ‘other’ procedures covered in the *BCSC* book

Refractive Surgery Overview

- Refractive Surgery
  - Intraocular
    - Pseudophakic
    - Phakic IOL
  - Corneal
    - Incisional
      - RK
      - AK
      - LRI
    - Laser
      - PRK
      - LASEK
      - Epi-LASIK
      - LASIK
      - SMILE
    - Other
      - **C**onductive **K**eratoplasty — ***CK***
      - **S**mall **A**perture **I**nlay — ***SAI***
      - **C**orneal **R**eshaping **I**nlay — ***CRI***
      - Corneal **CROSS** **L**inking — ***CXL***
      - **I**ntrastromal **C**orneal **R**ing **S**egments — ***ICRS***

These three treat presbyopia

Refractive Surgery Overview



Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

In **CK**, a thermal probe is used to produce a set of focal corneal scars. The scars produce local corneal steepening, thereby increasing convergence and improving vision at near.

Conductive **K**eratoplasty — ***CK***

Small **A**perture **I**nlay — ***SAI***

Corneal **R**eshaping **I**nlay — ***CRI***

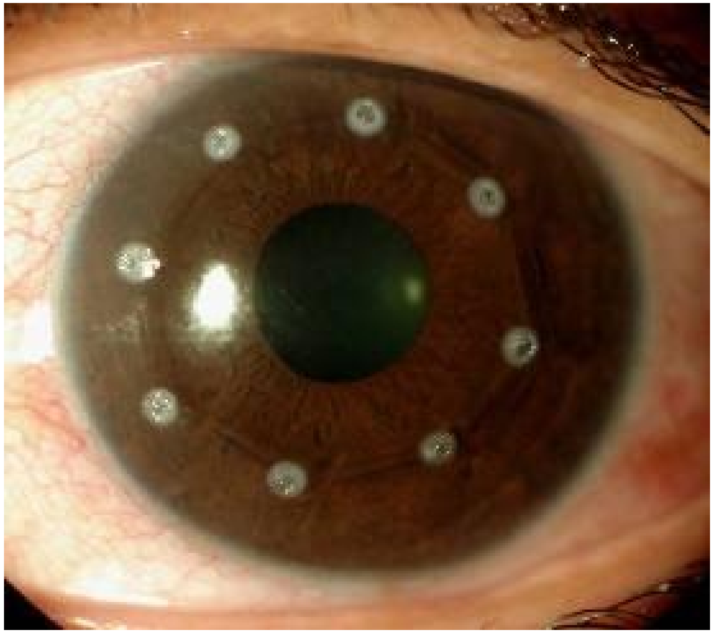
Corneal **CROSS L**inking — ***CXL***

Intrastromal **C**orneal **R**ing **S**egments — ***ICRS***

Over

CK probe

CK in action



CK scars

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

In **CK**, a thermal probe is used to produce a set of focal corneal scars. The scars produce local corneal steepening, thereby increasing convergence and improving vision at near.

The **SAI** is a tiny donut-shaped disc that is implanted in the central corneal stroma. Its central aperture produces a pinhole effect to improve near vision.

SMILE

Conductive **K**eratoplasty — *CK*

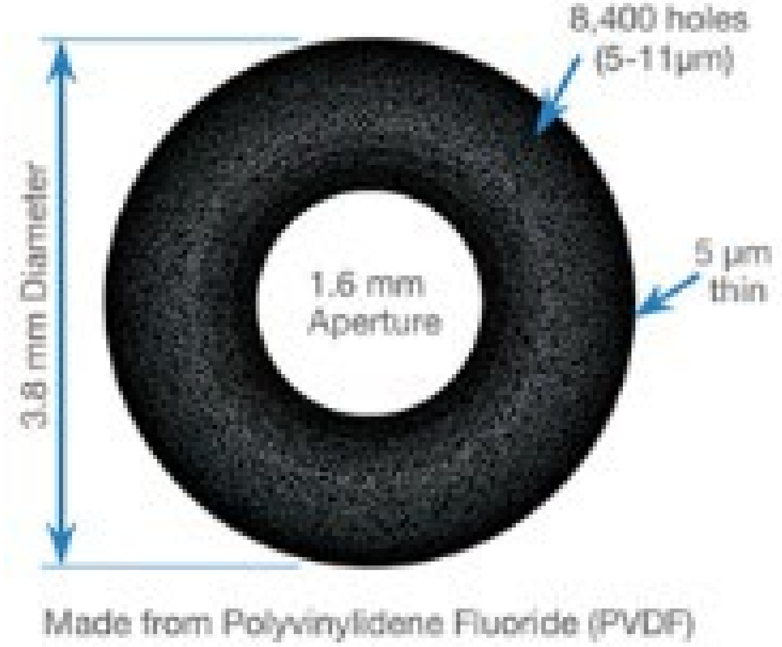
Small **A**perture **I**nlay — ***SAI***

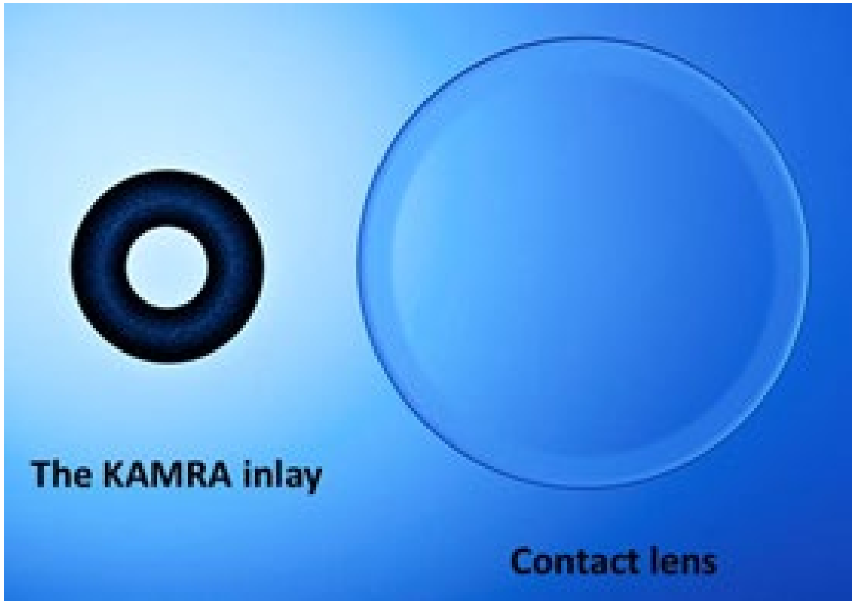
Corneal **R**eshaping **I**nlay — *CRI*

Corneal **CROSS L**inking — *CXL*

Intrastromal **C**orneal **R**ing **S**egments — *ICRS*

Refractive Surgery Overview





SAI

Refractive Surgery Overview

SAI

Refractive Surgery Overview

Refractive Surgery

Intraocular

Corneal

Pseudophakic

In **CK**, a thermal probe is used to produce a set of focal corneal scars. The scars produce local corneal steepening, thereby increasing convergence and improving vision at near.

The **SAI** is a tiny donut-shaped disc that is implanted in the central corneal stroma. Its central aperture produces a pinhole effect to improve near vision.

Like the SAI, the **CRI** is a tiny device implanted in the central corneal stroma. However, its mechanism of action is different—it is disc-shaped, and its central 'bump' increases the curvature of the overlying corneal surface, increasing power and thus improving near vision.

SMILE

Conductive **K**eratoplasty — *CK*

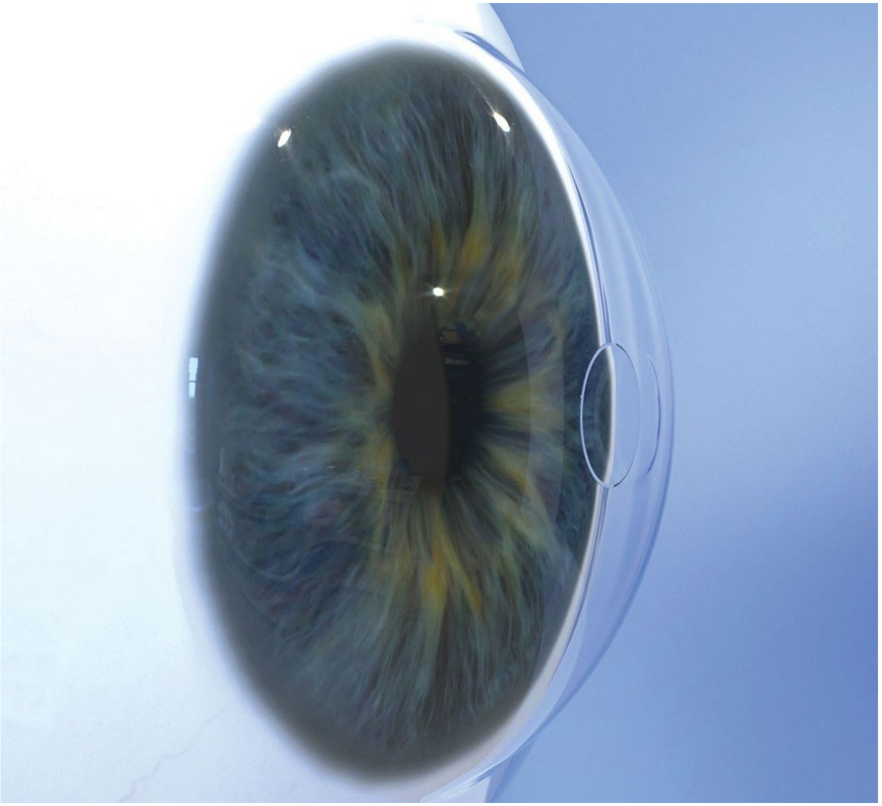
Small **A**perture **I**nlay — *SAI*

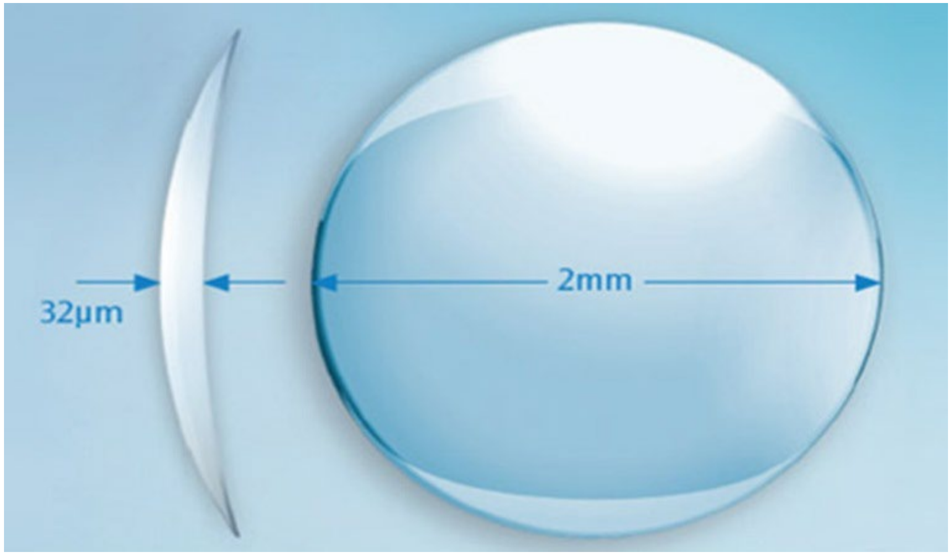
Corneal **R**eshaping **I**nlay — ***CRI***

Corneal **CROSS L**inking — *CXL*

Intrastromal **C**orneal **R**ing **S**egments — *ICRS*

Refractive Surgery Overview





CRI

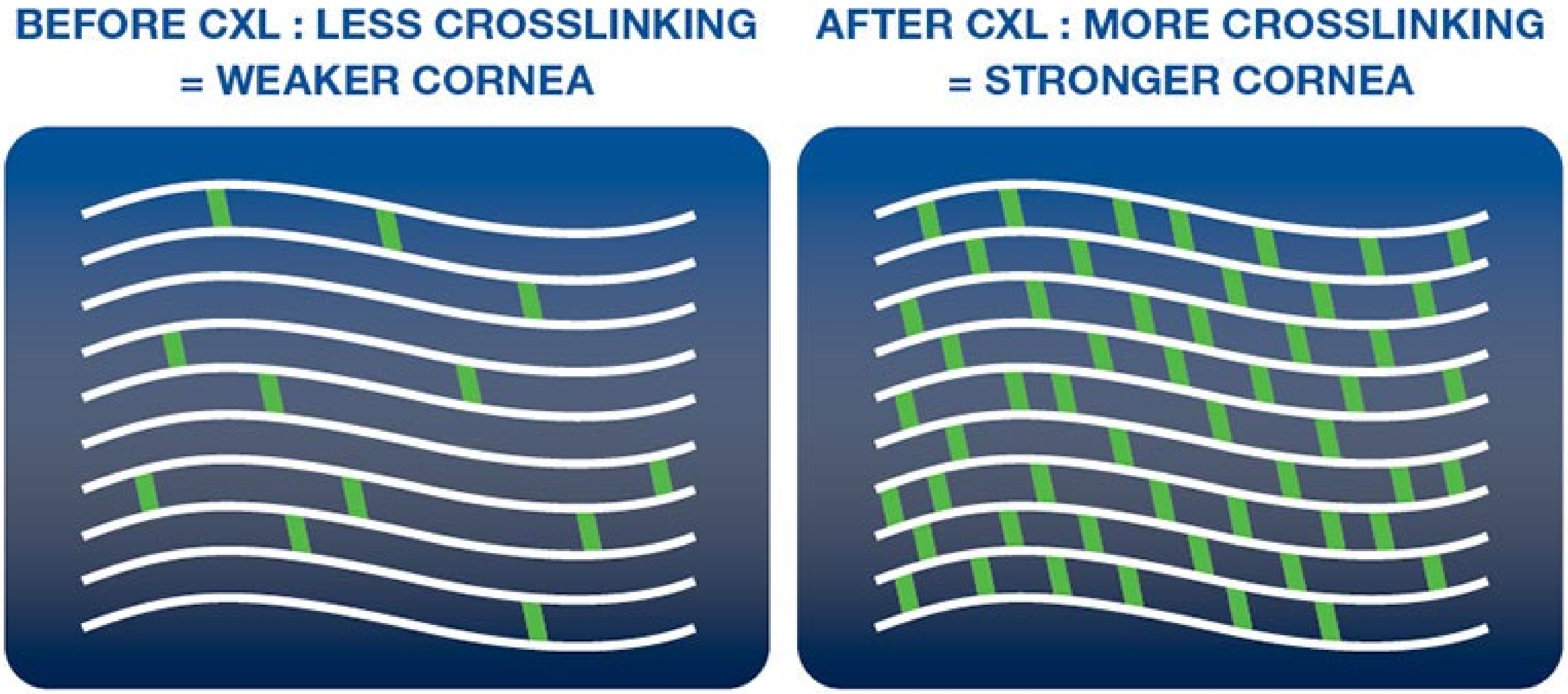
Refractive Surgery Overview

Refractive Surgery

- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - RK
    - AK
    - LRI
  - Laser
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
    - SMILE
  - Other
    - CK
    - SAI
    - CRI
    - **C**orneal **CROSS L**inking — ***CXL***
    - **I**ntrastromal **C**orneal **R**ing **S**egments — *ICRS*

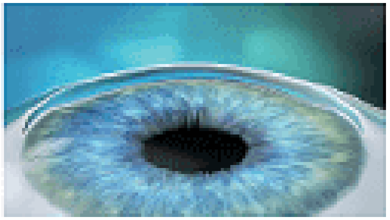
CXL involves the induction of a chemical reaction that strengthens the bonds between corneal stroma fibrils. The result is a stabilization of the keratoconus process.

Refractive Surgery Overview

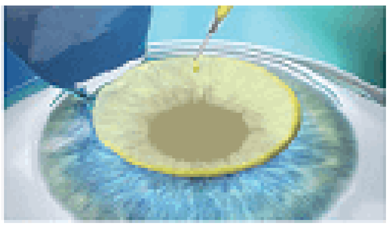


CXL concept

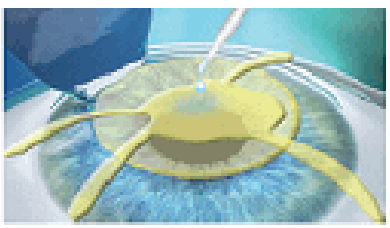
Refractive Surgery Overview



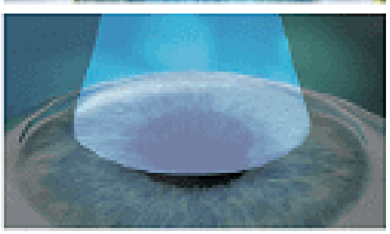
1. We remove the Epithelium



2. Ribloflavin (Vitamin B2) eye drops are applied onto the cornea



3. 1 minute later, the solution is irrigated or washed away by the surgeon



4. An ultra-violet light (UVA) illuminates the Riboflavin solution for the corneal cross-linking procedure

CXL: Process

Refractive Surgery Overview

CXL: Process

Refractive Surgery Overview

Refractive Surgery

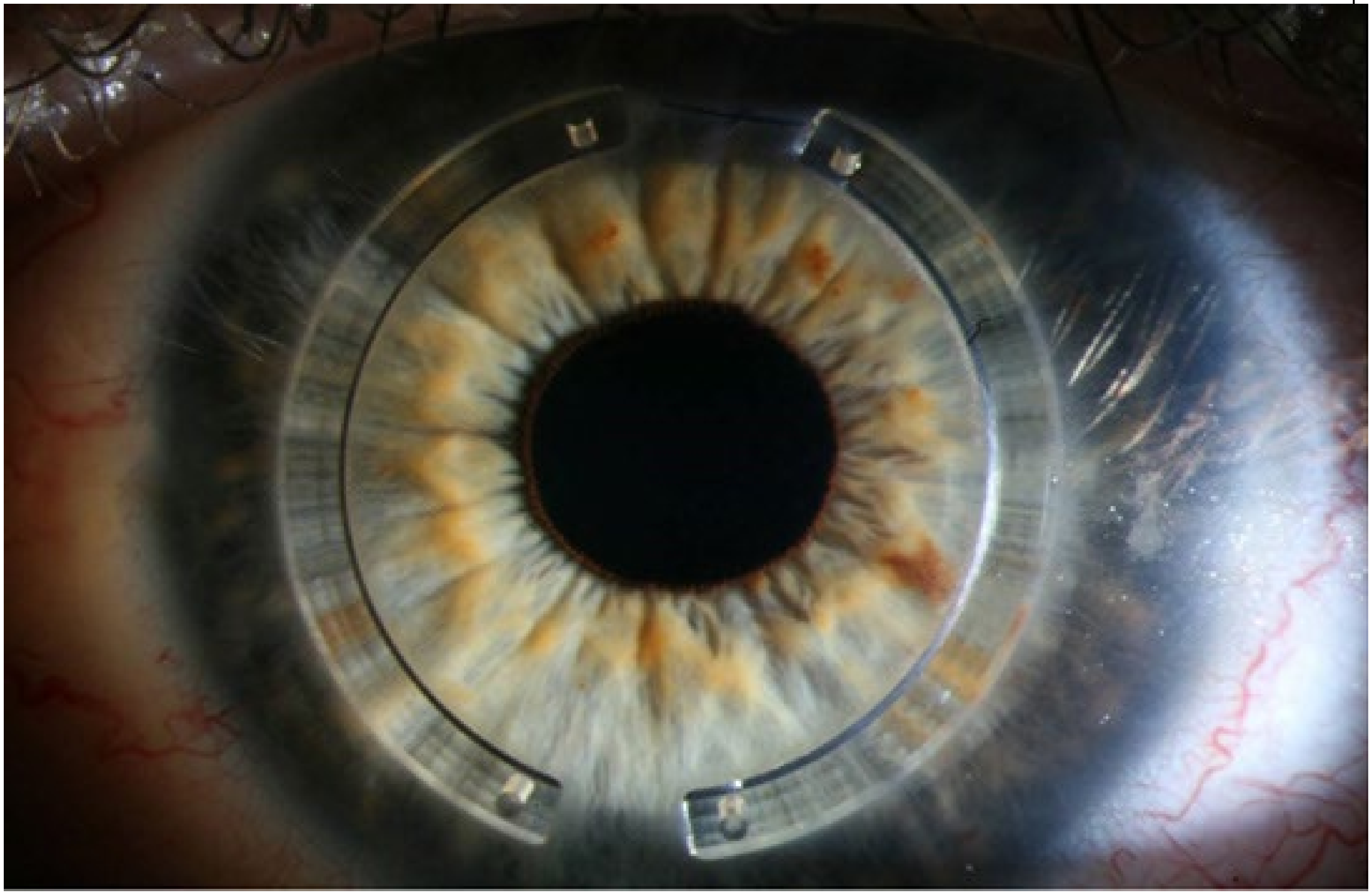
- Intraocular
  - Pseudophakic
  - Phakic IOL
- Corneal
  - Incisional
    - RK
    - AK
    - LRI
  - Laser
    - PRK
    - LASEK
    - Epi-LASIK
    - LASIK
    - SMILE
  - Other
    - CK
    - SAI
    - Corneal Reshaping Inlay — CRI
    - Corneal CROSS Linking — CXL
    - **I**ntrastromal **C**orneal **R**ing **S**egments — ***ICRS***

CXL involves the induction of a chemical reaction that strengthens the bonds between corneal stroma fibrils. The result is a stabilization of the keratoconus process.
ICRS employs semicircular segments of PMMA. These segments are placed in the peripheral corneal stroma, where they produce local flattening.

Refractive Surgery Overview

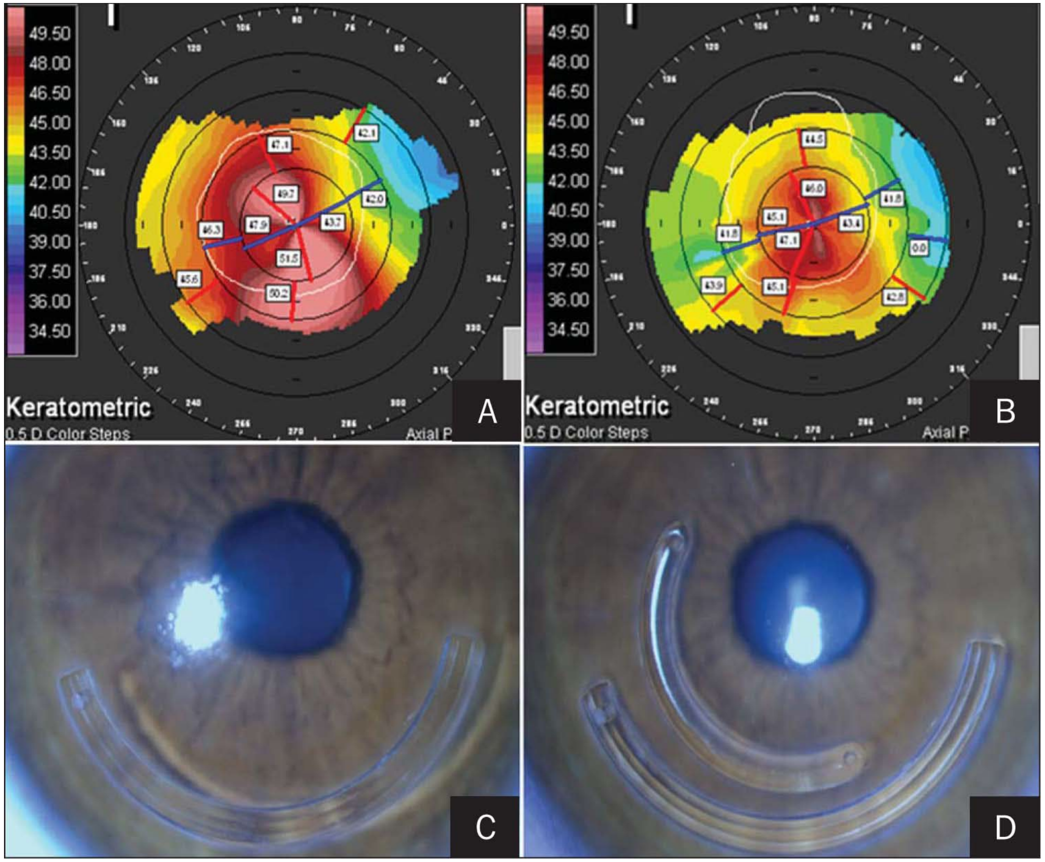
Intrastromal ring segments

Refractive Surgery Overview



Intrastromal ring segments *in situ*

Refractive Surgery Overview



Intrastromal ring segments placed for KCN

Refractive Surgery Overview

That's it! Go through this slide-set a couple of times (at least) until you feel like you have a handle on it. When you're ready, do slide-set *RS1*, which covers this material in a Q&A format (and more detail).