

Refractive Surgery: Overview & Potential Complications

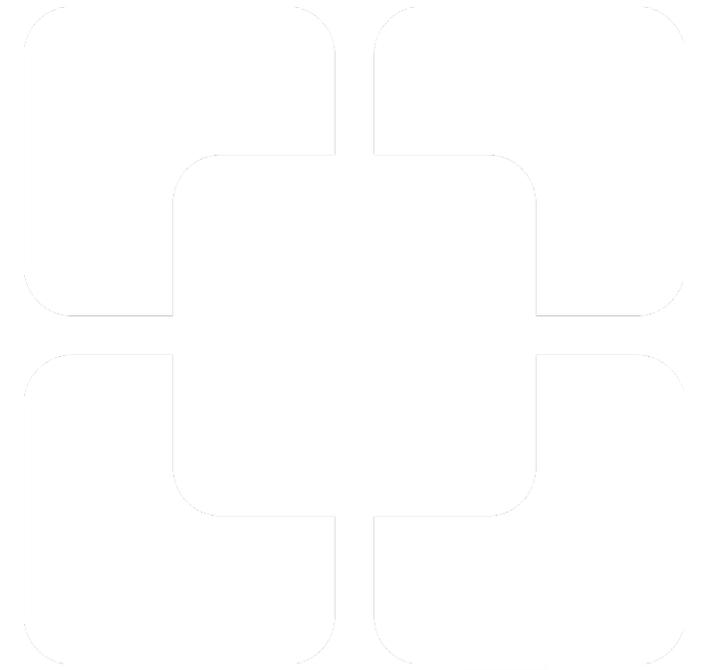
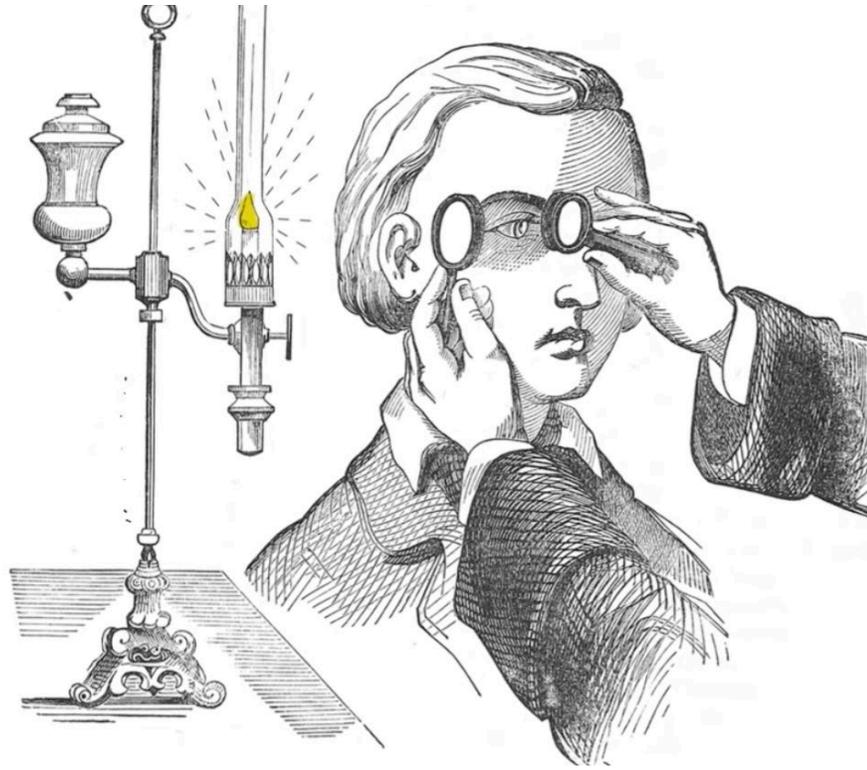


Cassandra C. Brooks, MD
Cornea & Refractive

Conflict of interest

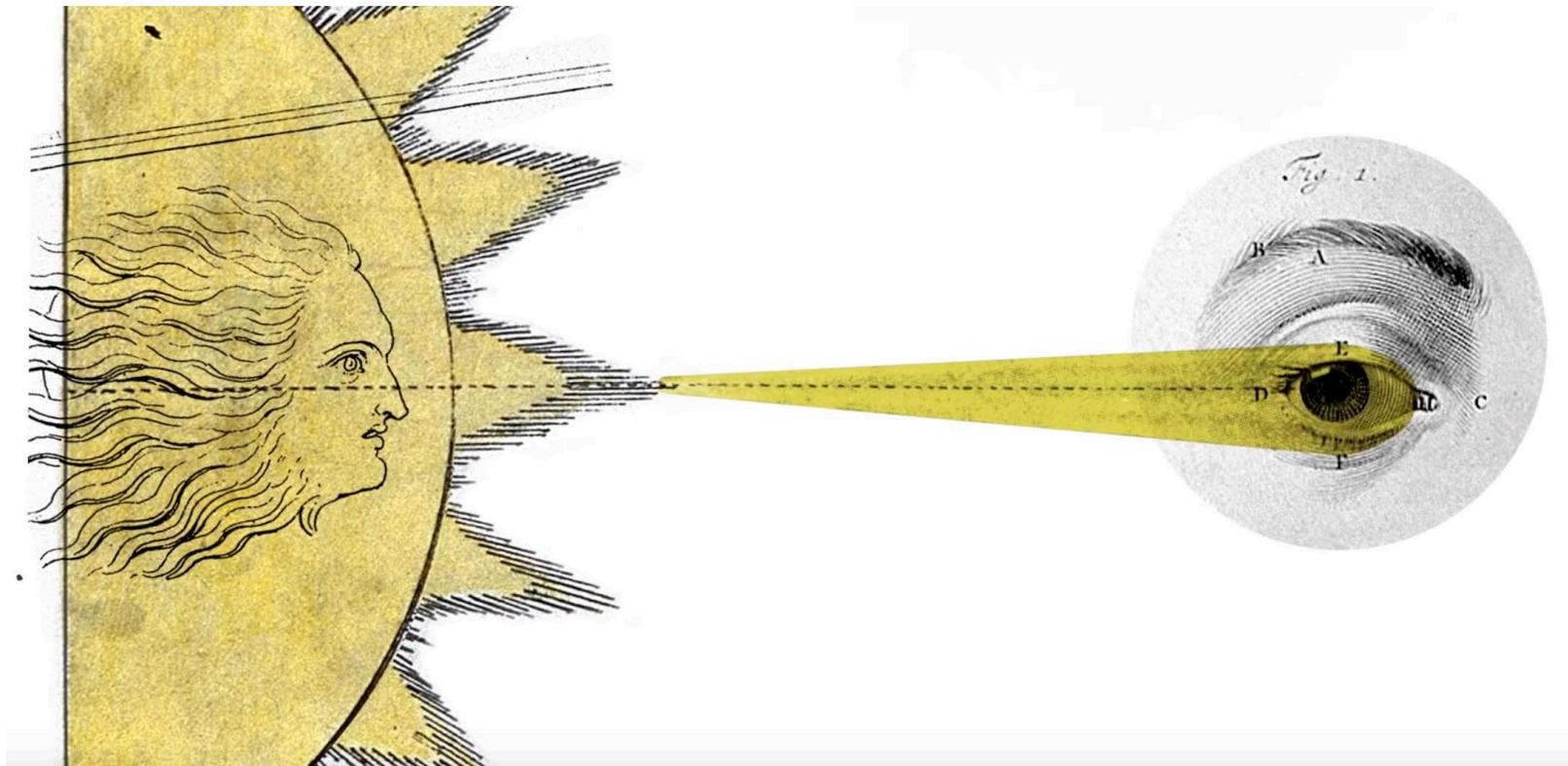
- None to disclose

What is refractive error?

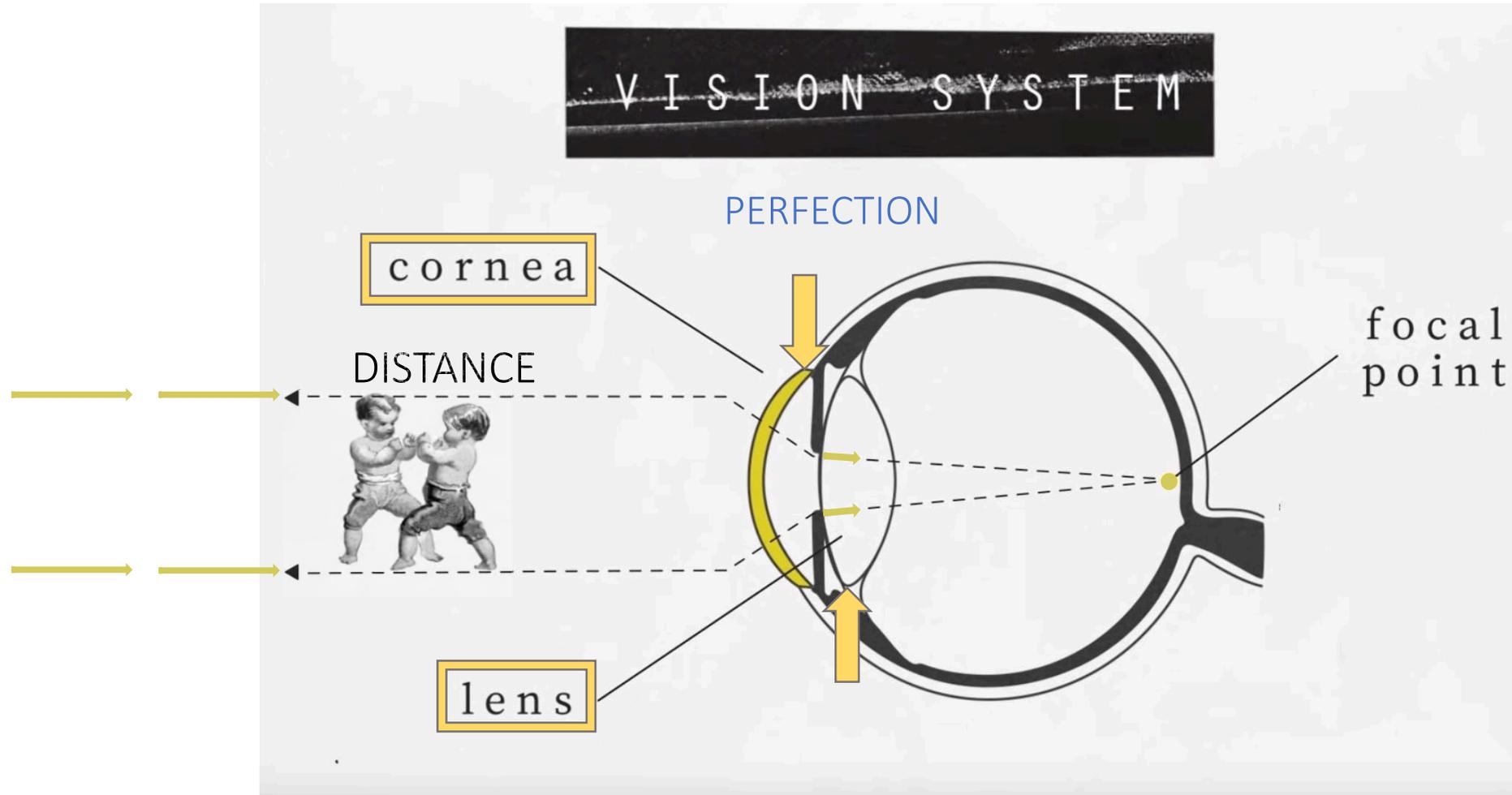


Refractive Error

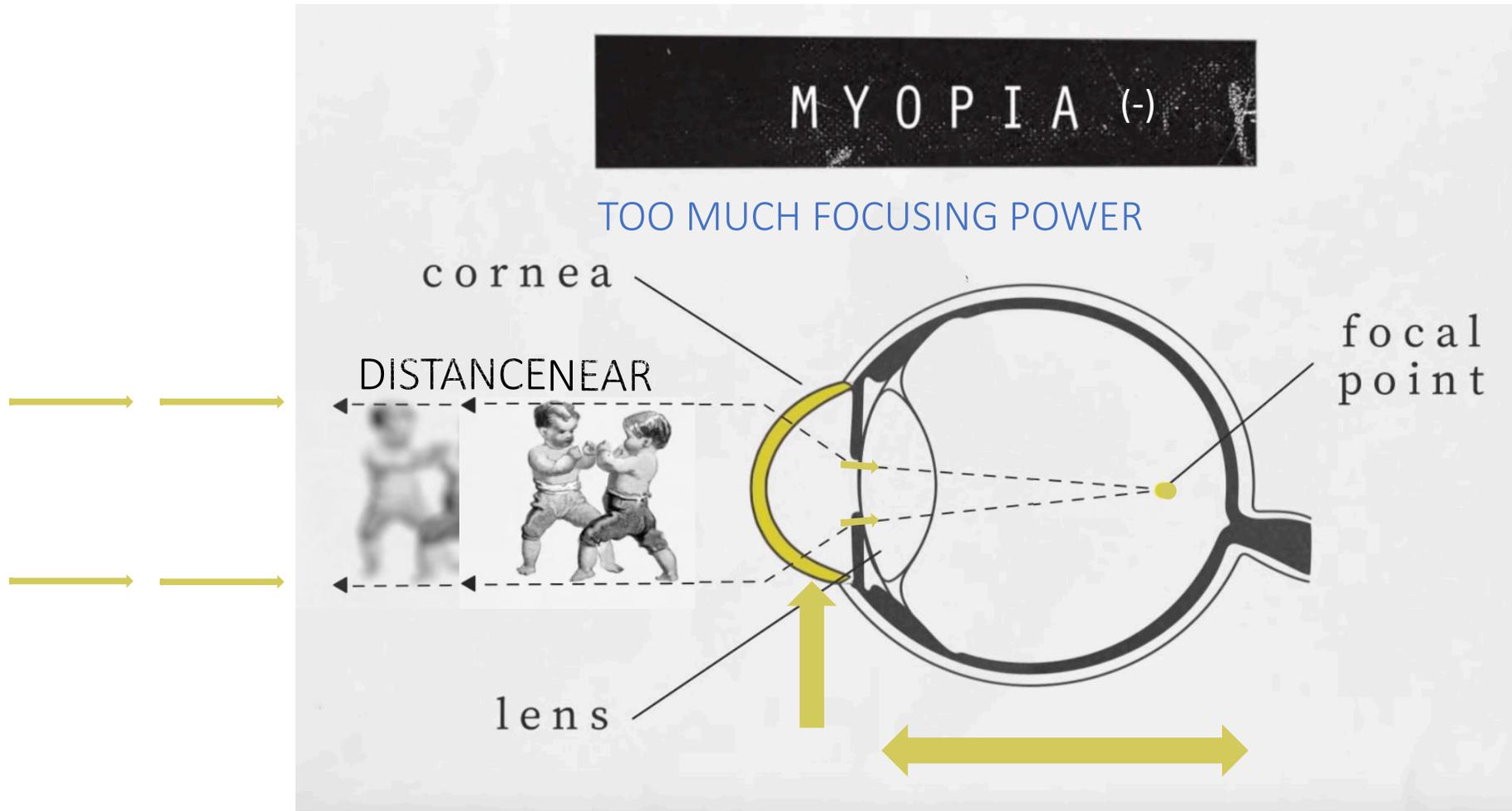
Imperfections in the ability of the eye to focus incoming light



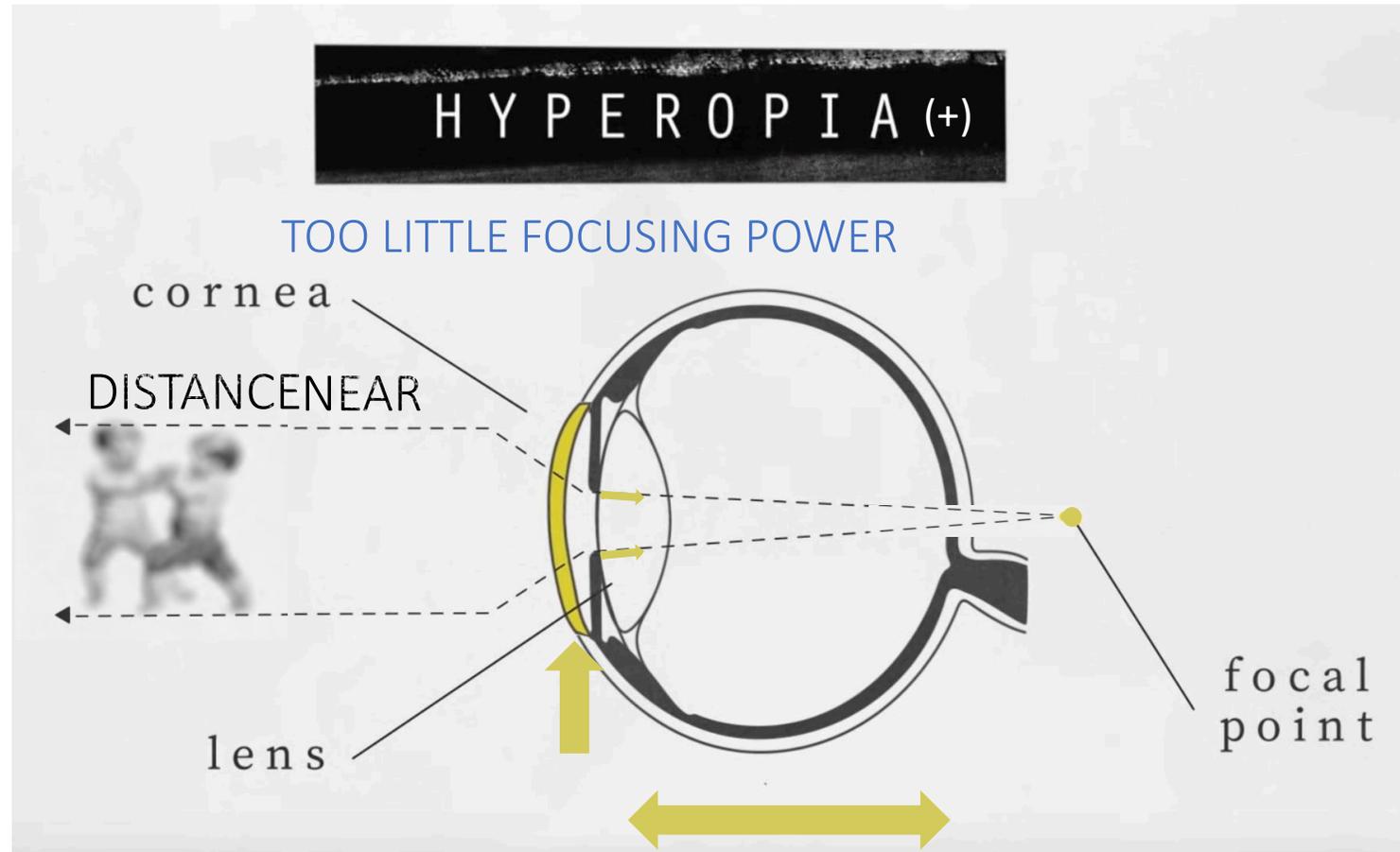
Refractive Error



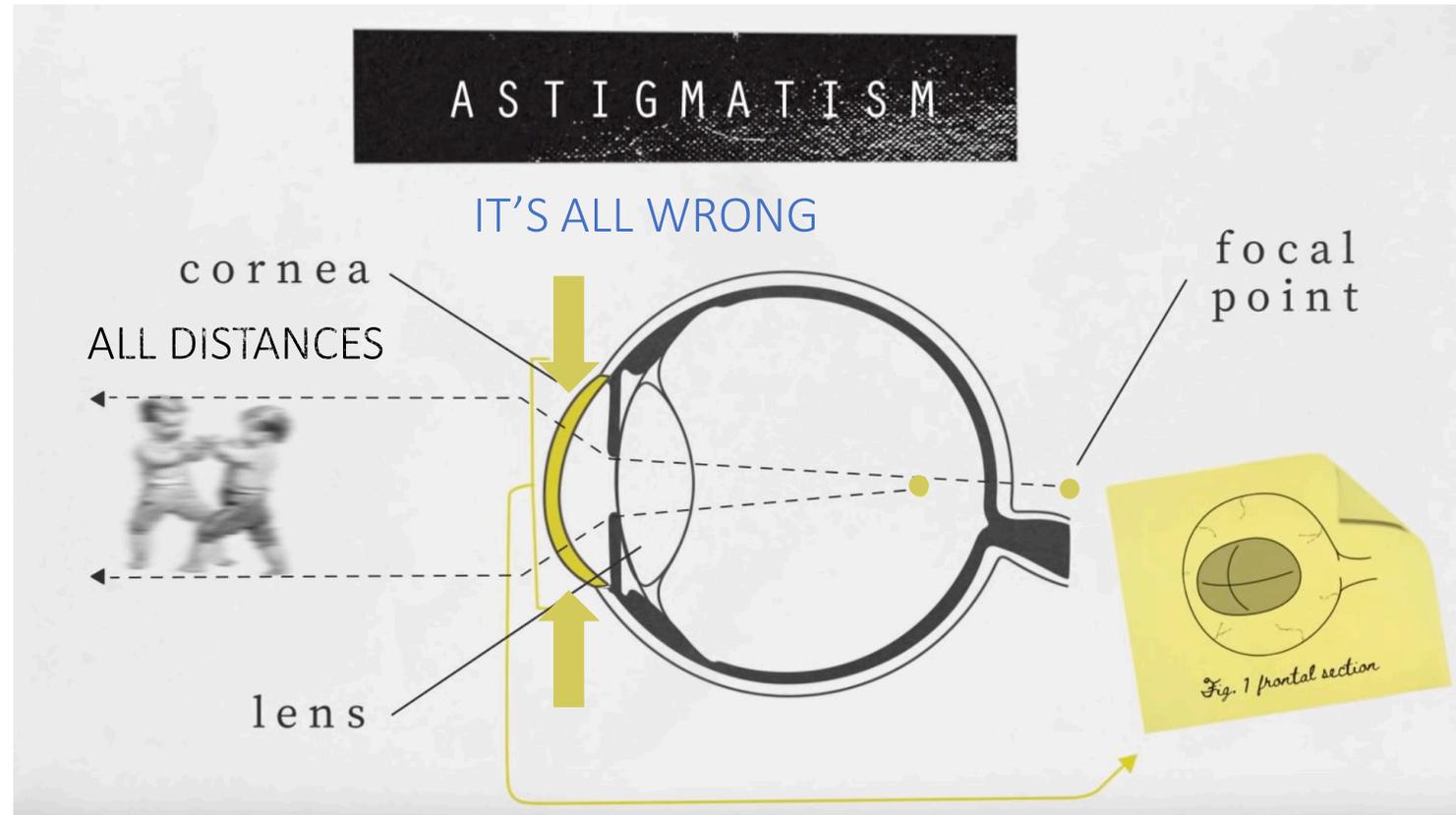
Refractive Error



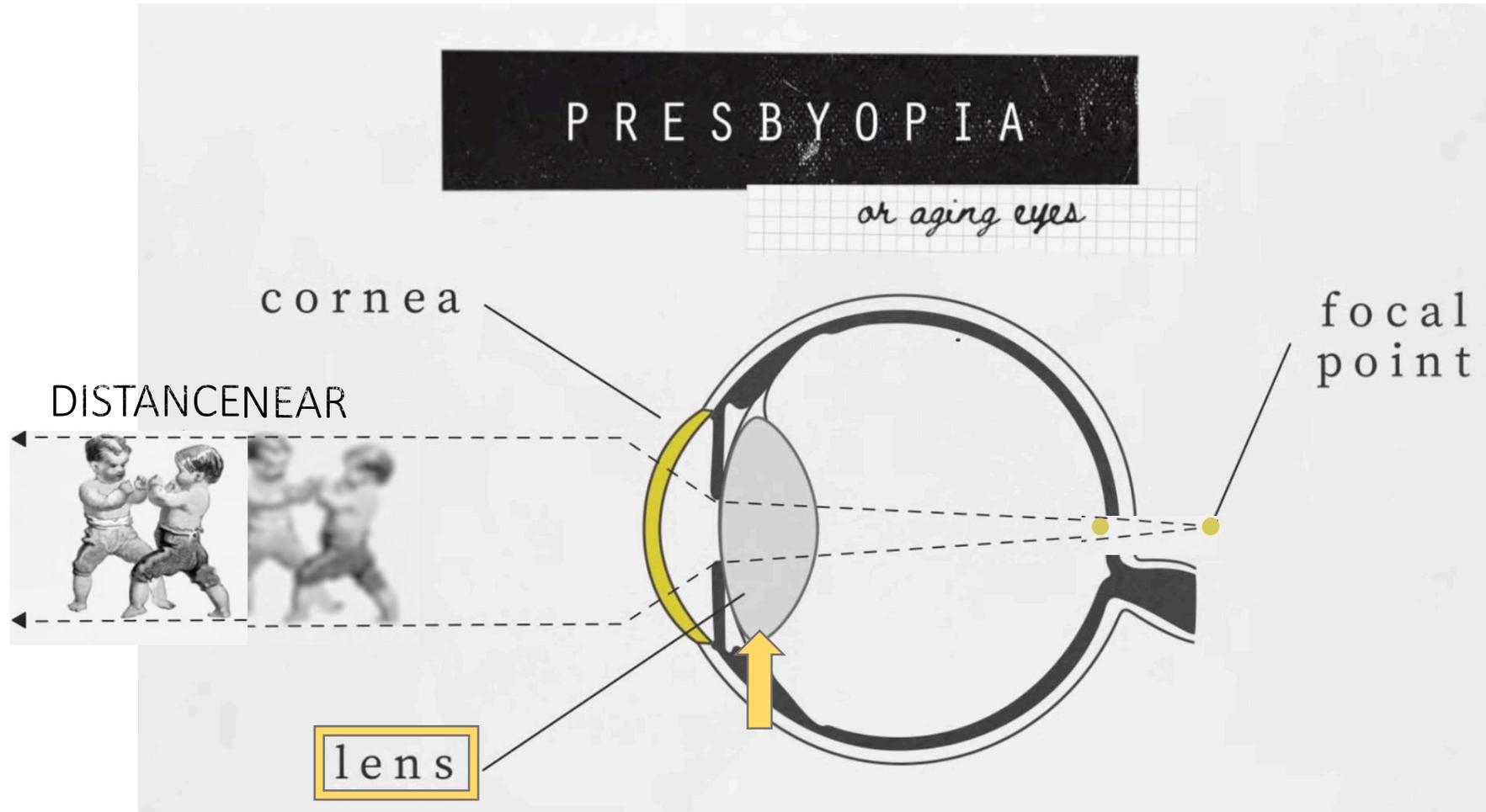
Refractive Error



Refractive Error



Refractive Error

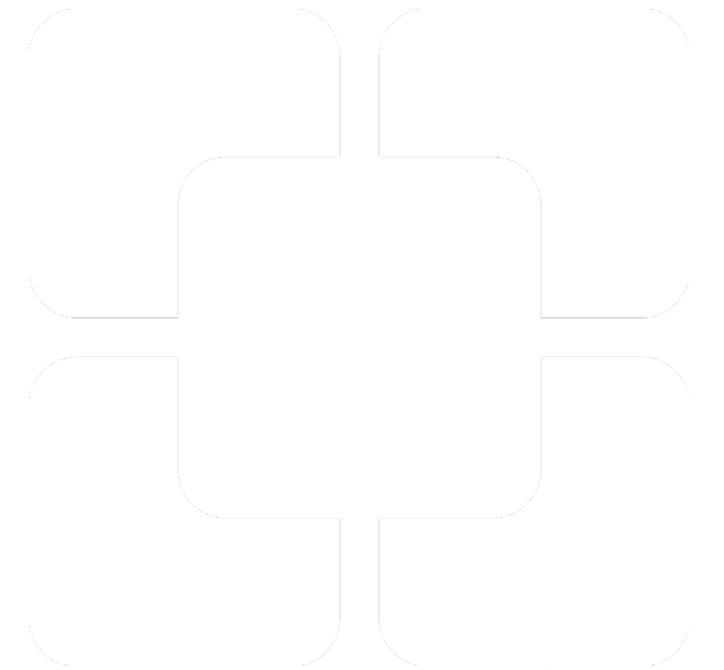
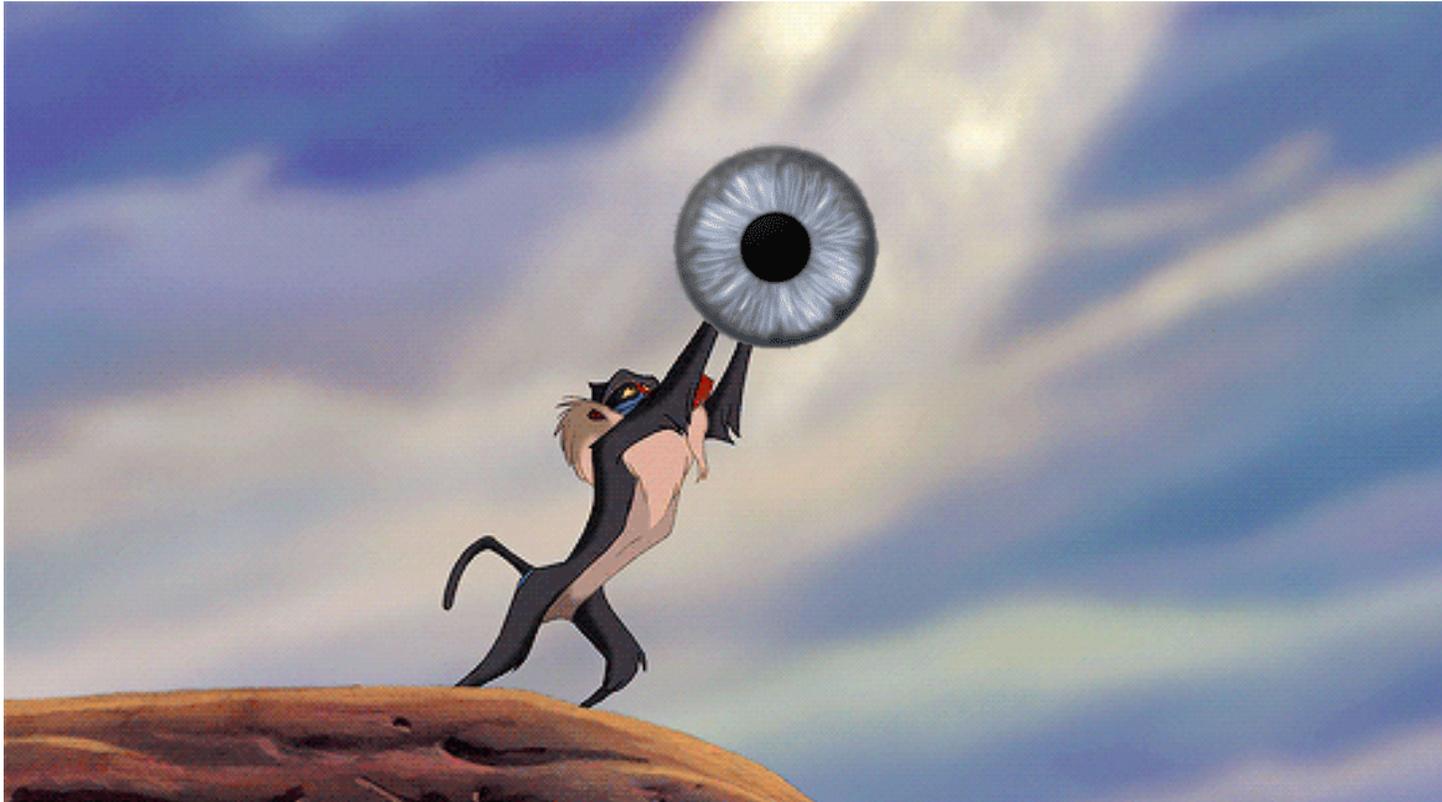


Refractive Error



Types of Refractive Surgery

* EXCLUDING CATARACT SURGERY



Types of Refractive Surgery

- Radial keratotomy (RK) 1970s
- Astigmatic keratotomy (AK)
- Onlay & Inlay
- Photorefractive keratectomy (PRK) 1980s
- Laser in-situ keratomileusis (LASIK) 1994
- Small incision lenticule extraction (SMILE) 2014

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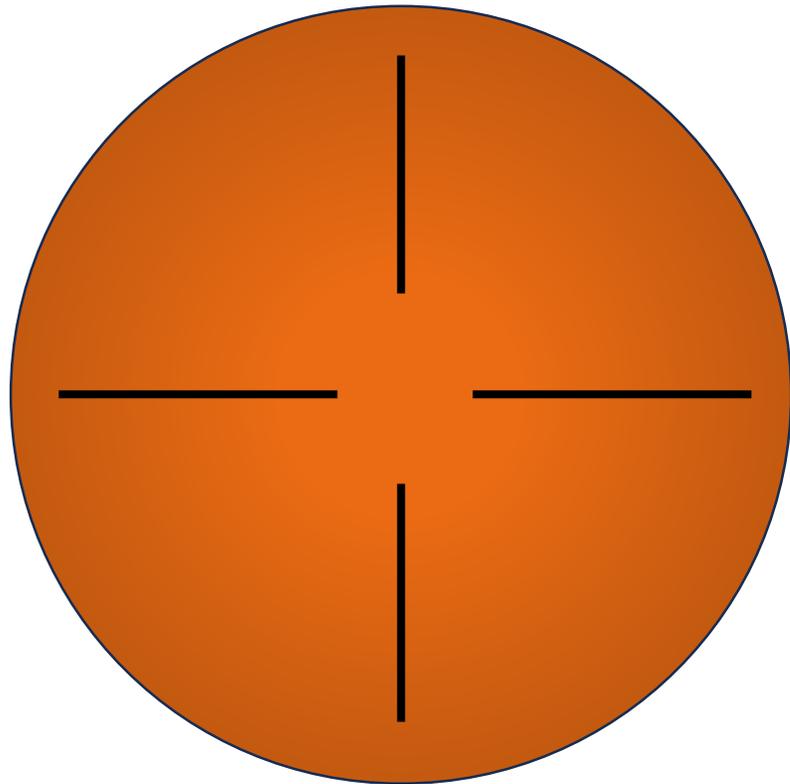
Radial Keratotomy (RK)



Radial Keratotomy (RK)

- Redistribution of power from center to periphery
- Treats: myopia

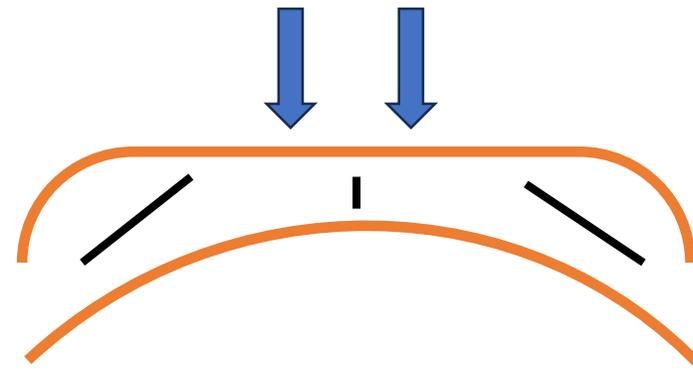
Radial Keratotomy (RK)



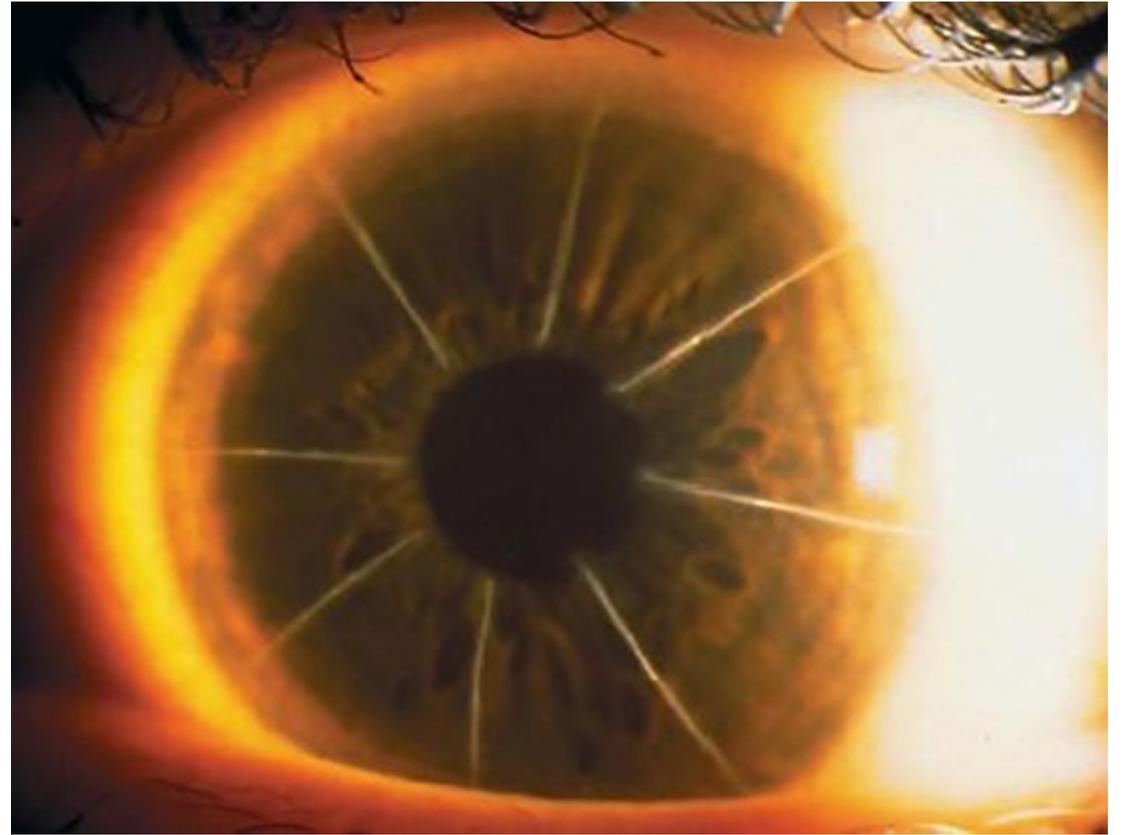
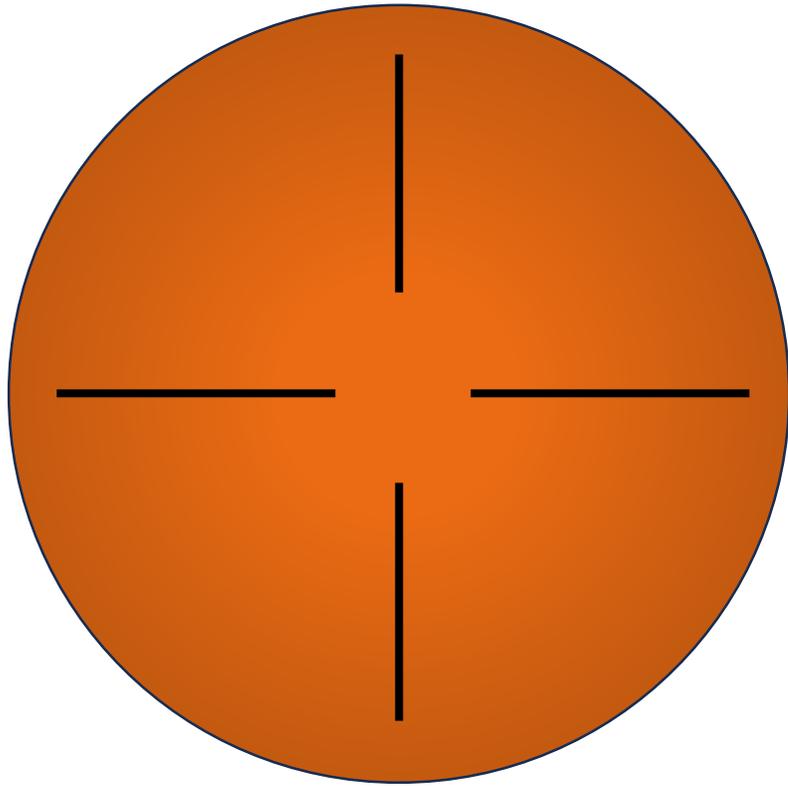
Before RK



After RK



Radial Keratotomy (RK)



Radial Keratotomy (RK)

- Redistribution of power from center to periphery
- Treats: myopia
- Outcomes (PERK study)
 - 53% sc 20/20
 - 85% sc 20/40 or better
 - 43% had ≥ 1 D hyperopic shift between 6mo to 10 years (higher risk with smaller optical zone)

Radial Keratotomy (RK)

- Redistribution of power from center to periphery
- Treats: myopia
- Complications:
 - 1-3% lost 2 lines or more
 - Glare/ starburst/ halo
 - Perforation
 - Refractive instability (progressive flattening)
 - Diurnal fluctuations (hypoxic edema during sleep --> flattening → hyperopic shift upon waking; improves during day)

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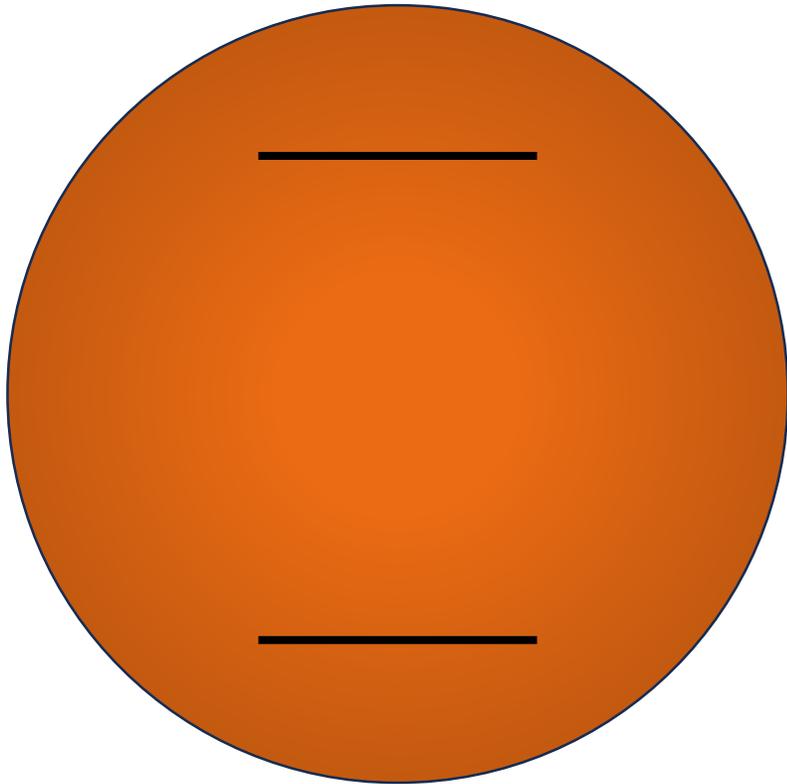
Astigmatic Keratotomy (AK)



Astigmatic Keratotomy (AK)

Based on **coupling** concept

Incisional meridian flattens, 90° away
steepens



Variables

Curved/ straight

Midperipheral/ limbal

Length

Technique

Blade vs femto-laser

Outcomes

4-20% overcorrection

Irregular astigmatism (AK>LRI)

Perforation

Dry eye

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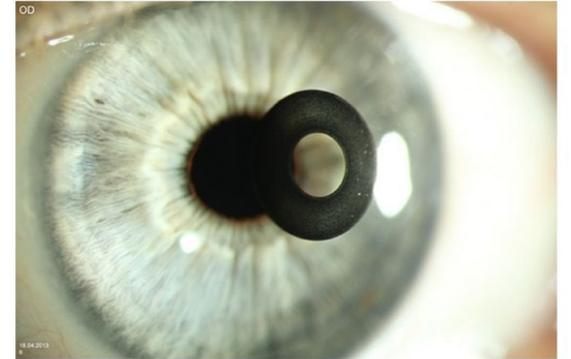
Onlay & Inlay



Onlay & Inlay

Keratophakia

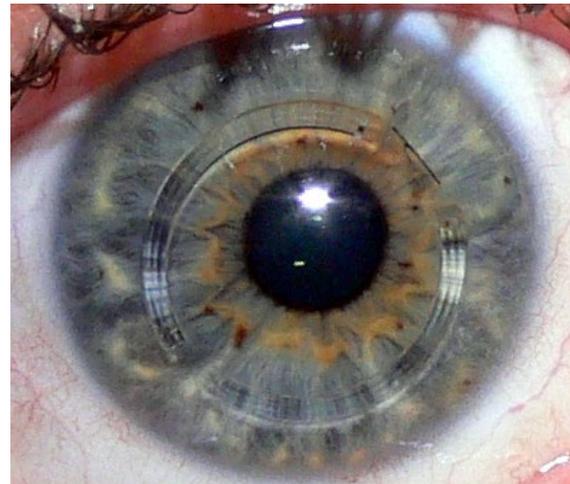
- Donor cornea placed intrastromal
 - Treat hyperopia & aphakia
 - Low refractive predictability (25% >3D off target)
- Epikeratoplasty: donor cornea lenticule on top of host cornea
 - Treat aphakia (later myopia, hyperopia, KCN)
 - Graft failure, infection, epi ingrowth, poor predictability, edema
- Inlay synthetic material
 - Treat presbyopia
 - Haze, decentration



Onlay & Inlay

Intrastromal cornea ring segment (INTACS)

- Treat low myopia (historically) & KCN (if >450 um clear centrally)
- Redistributes cornea power
- PMMA arcuate placed intrastromally (70% depth)
 - Thicker segment = greater correction
- Avoid: hx ocular HSV, K dystrophy, variety autoimmune def, immunodeficiency, breastfeeding
- Complications:
 - Perforation/ extrusion
 - Infection
 - Over/ under correction
 - KNV
 - Glare/halos
 - Decreased K sensitivity

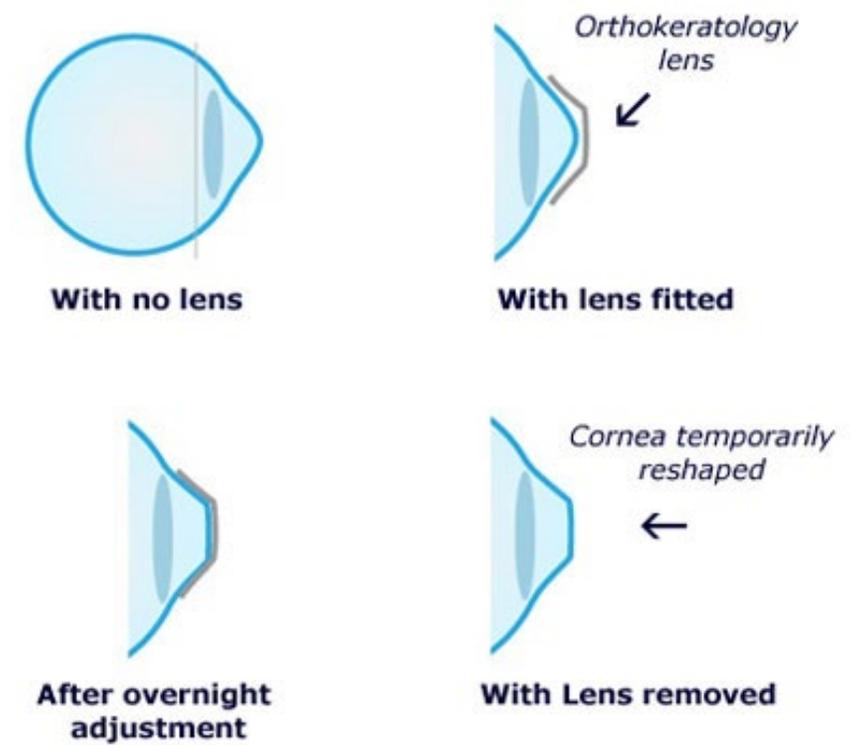


Onlay & Inlay

Orthokeratology

- RGP overnight to temporarily flatten cornea (→ reduce myopia)
- Range: -0.5 to -6.0D, up to 1.75D astig
- 75% report discomfort
- Complications
 - Infection
 - RCE
 - Induced astigmatism

Orthokeratology



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Equipment

Femtosecond Laser



LASIK / SMILE

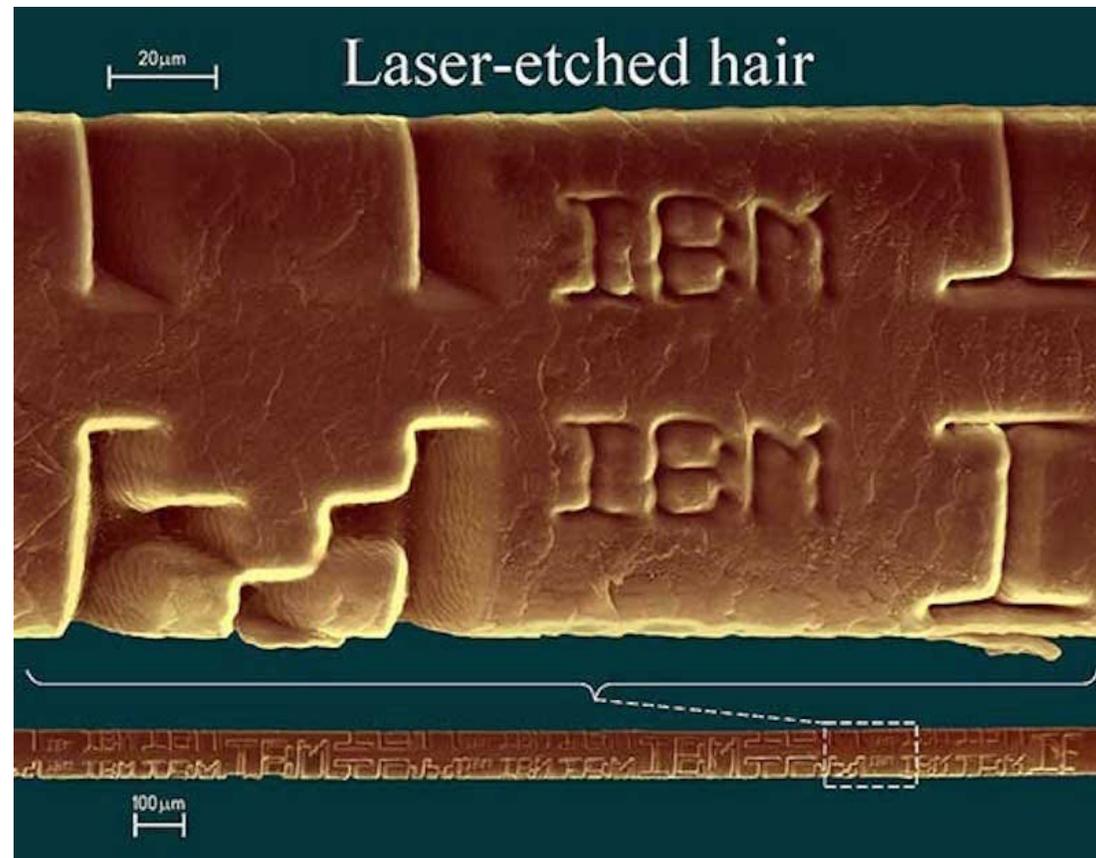
Femtosecond + Excimer Laser

Excimer Laser



LASIK/ PRK

Excimer laser



Candidates

Age 18 years or older

Stable refraction of at least one year's duration (0.5D within 1 yr)

Myopia between -0.50 and -12.00 diopters

Astigmatism 5.00 diopters

Hyperopia $< +6.00$ diopters



* Variable with surgeon
/ laser platform

Not Candidates

Absolute

Keratoconus/ corneal ectasia
Herpetic keratitis
Progressive myopia
Certain corneal diseases
Glaucoma
Cataract

Relative

Dry eye
Blepharitis
Uncontrolled vascular disease
Autoimmune disease
Immunosuppressed/immunocompromised
Pregnant/ nursing
History of keloids
Diabetes mellitus
Accutane (6m pre/post)
Allergies/ Anti-histamines
Unrealistic expectations

* Most things in life are not absolute

Types of Refractive Surgery

- PRK
 - LASIK
 - SMILE
-
- ê **LASEK** (Laser Epithelial Keratomileusis): modification of PRK, epithelium is preserved as a flap
 - ê **Epi-LASIK**: modification of LASIK, epithelial flap cut with microkeratome with blunt blade

Math Basics

1 D correction \sim 15um tissue

Residual stromal bed (RSB)

Goal: $>250\mu\text{m}$ (most $>300\mu\text{m}$)

Percent tissue altered (PTA) = $(D \times 15) / \text{CCT}$

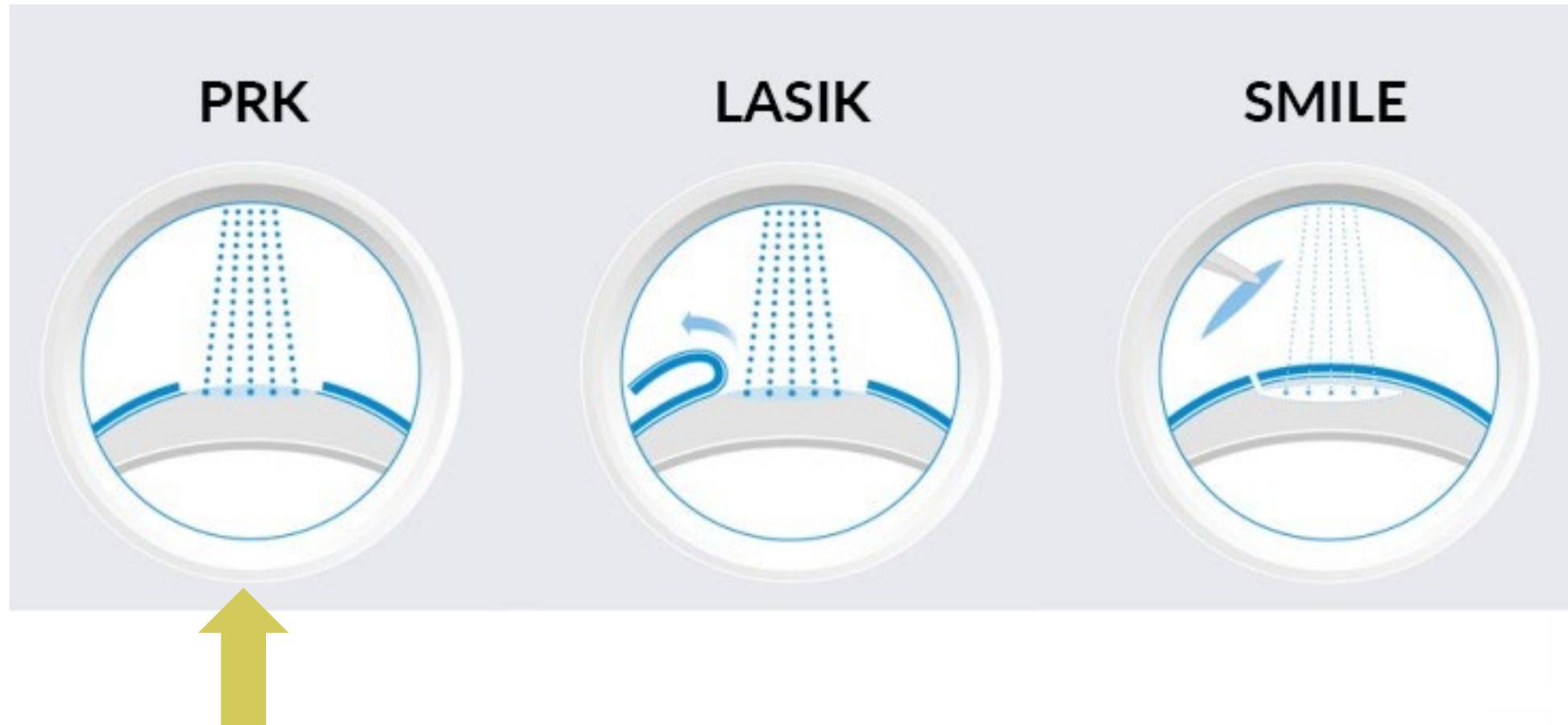
LASIK specific equation

$>40\%$ = higher risk ectasia

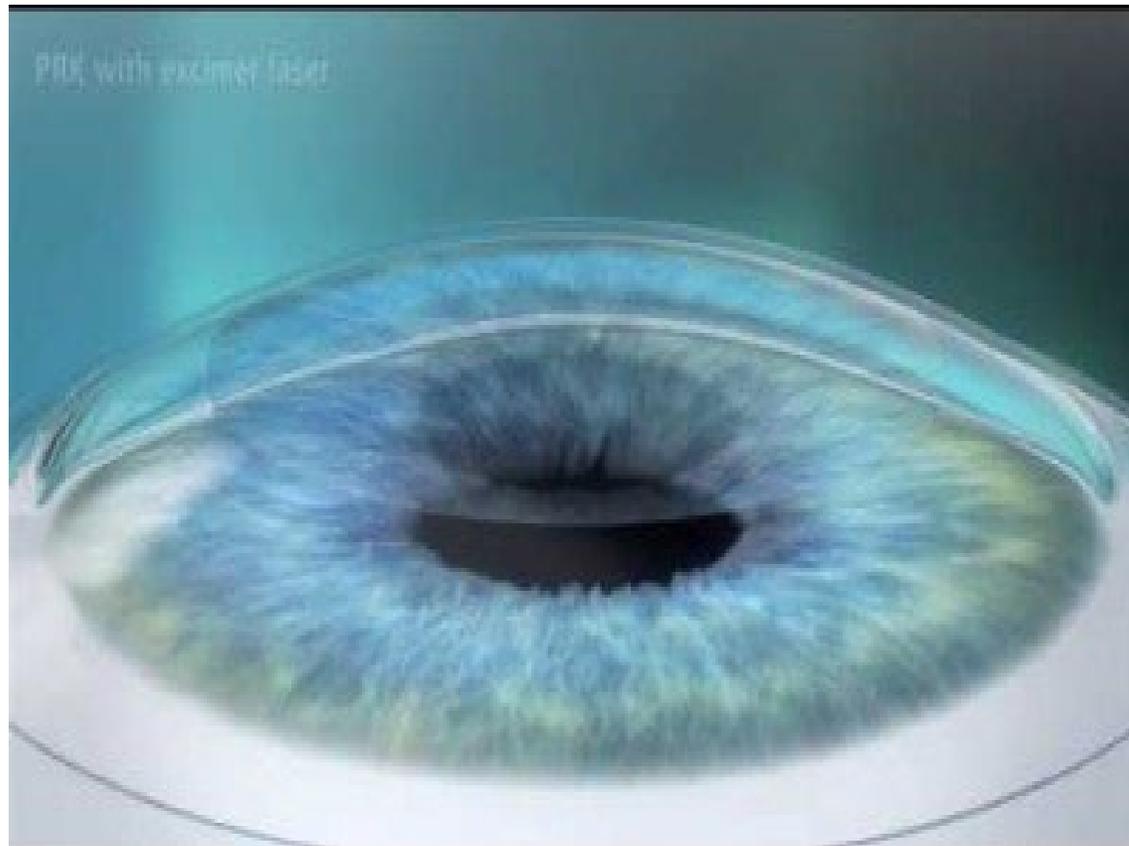
Types of Refractive Surgery

- PRK
- LASIK
- SMILE

PRK



PRK

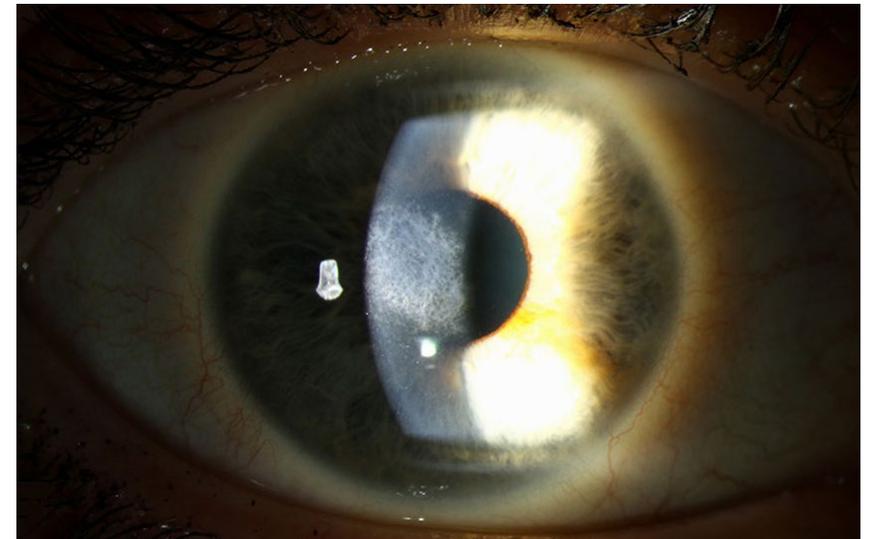
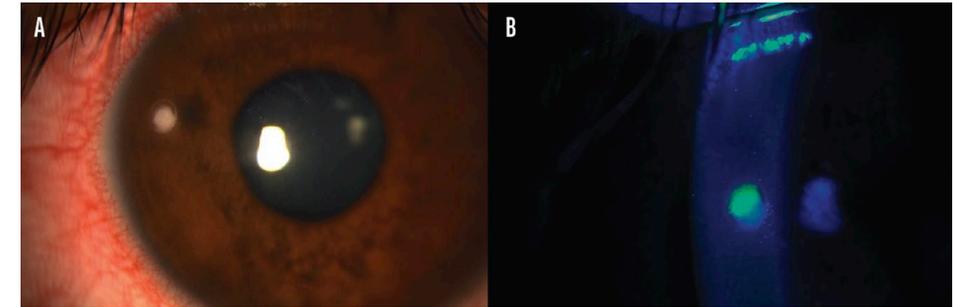


PRK

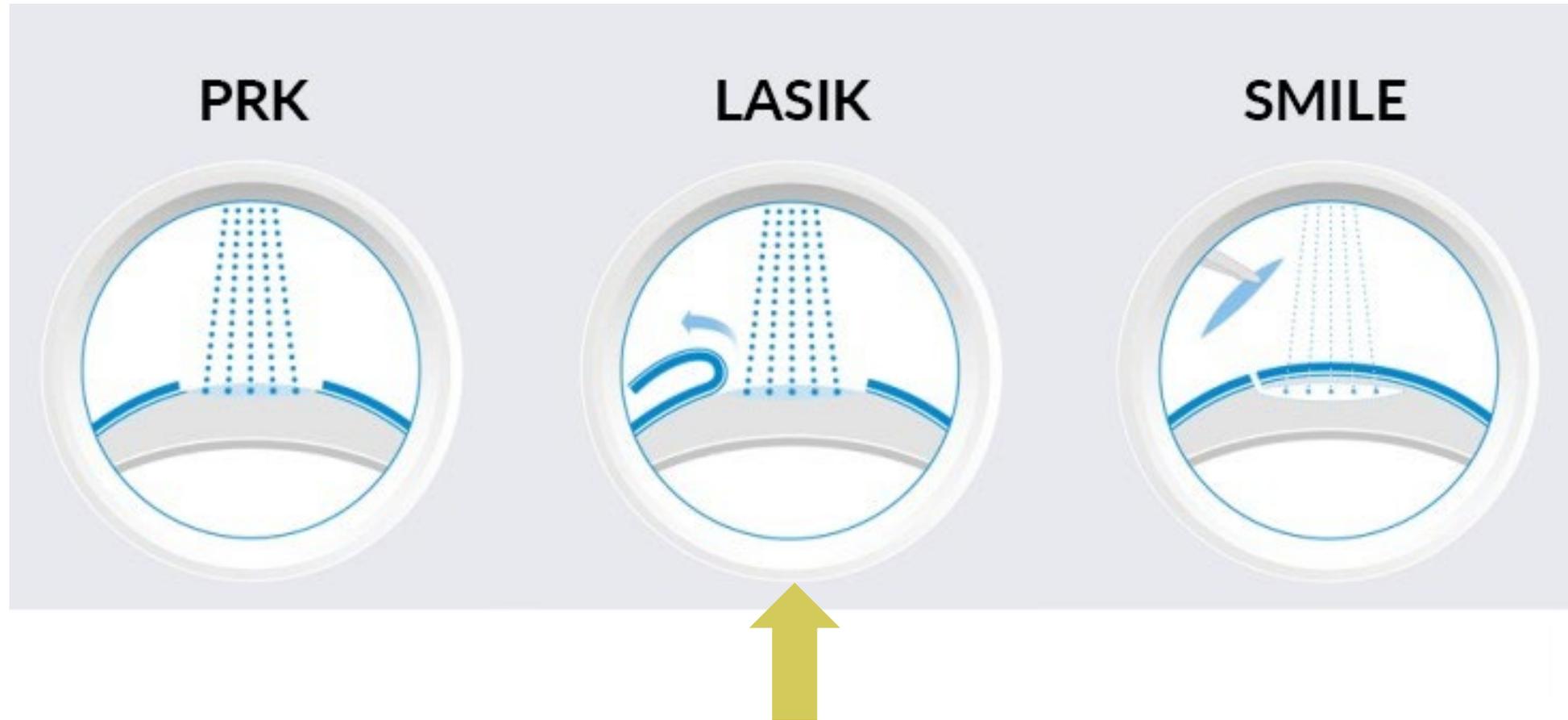
- Common indications:
 - Thin cornea
 - High Mrx
 - K scar
 - ABMD

PRK

- PRK-specific complications
 - Persistent epithelial defect
 - Can result in: haze, infection, irregular astigmatism
 - Sterile infiltrate
 - Haze
 - Decreased with MMC use
 - Peak 1-2 months
 - Resolve 6-12 months



LASIK



LASIK

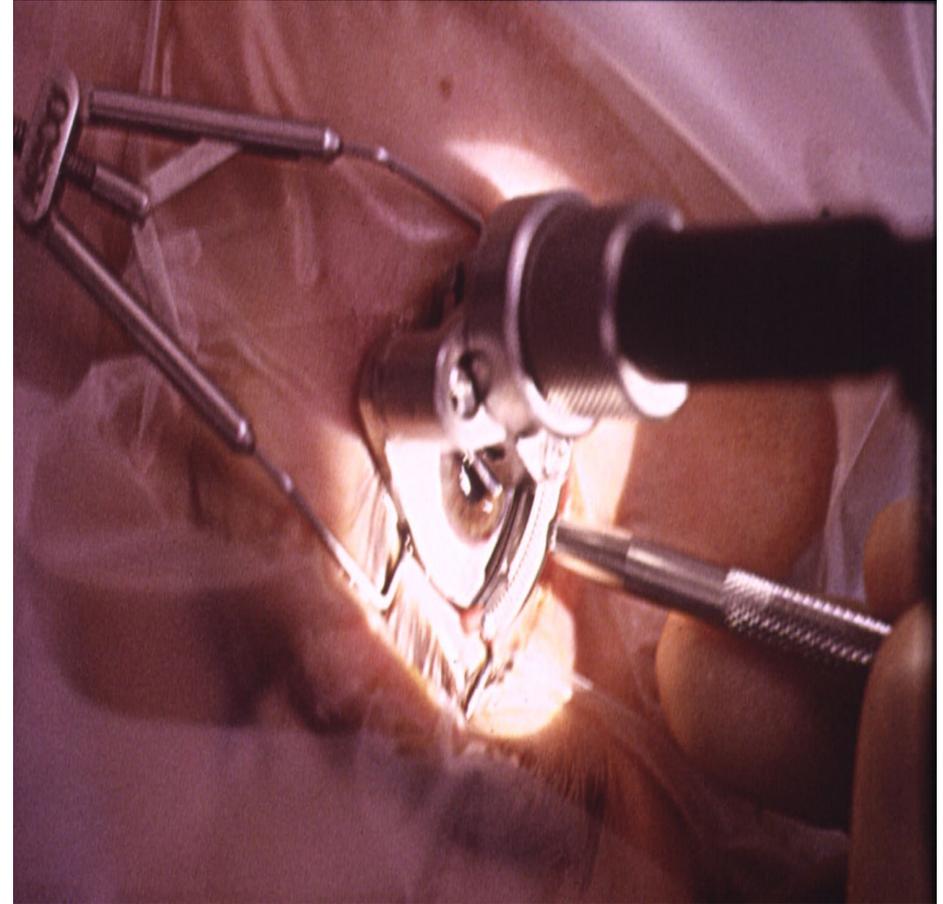


LASIK

- Techniques
 - Microkeratome
 - Laser

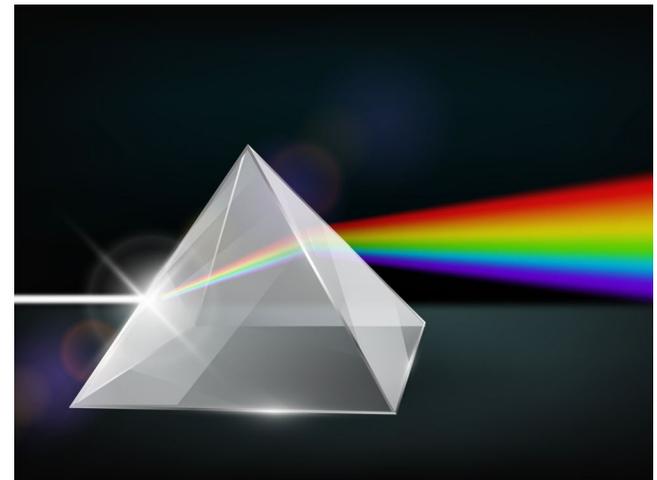
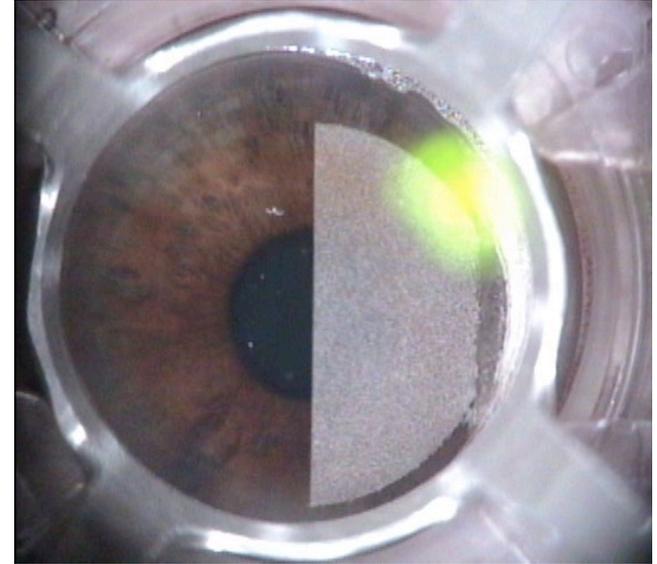
LASIK

- Techniques
 - Microkeratome
 - Thin flap/ Buttonhole (>48D)
 - Free flap (<40D)
 - Perforation
 - Laser



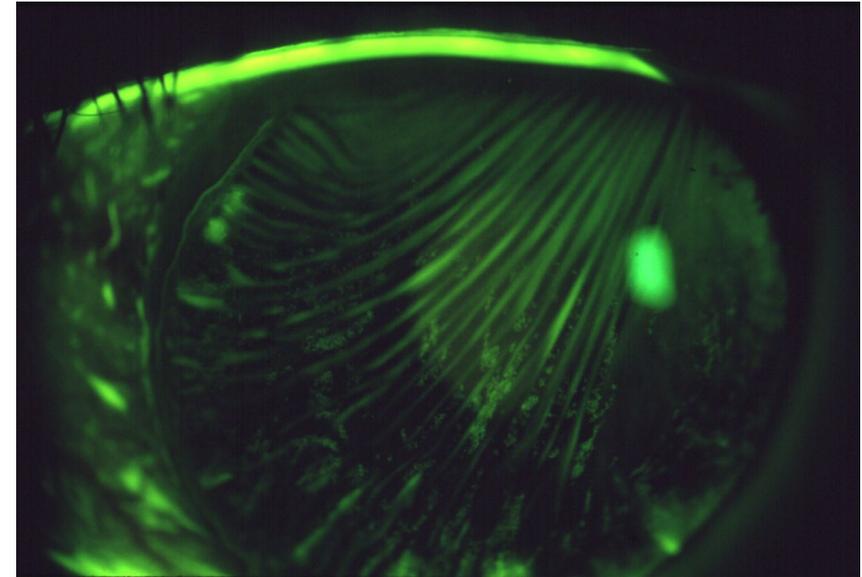
LASIK

- Techniques
 - Microkeratome
 - Laser
 - Subtypes
 - Wavefront optimized
 - Wavefront guided (customized; treat HOAs)
 - Complications
 - Suction loss (~2%)
 - Older excimer model
 - Opaque bubble layer (OPL)
 - Rainbow glare



LASIK

- Techniques
 - Microkeratome
 - Laser
- Complications (both):
 - Epithelial slough or defect
 - Flap striae
 - Micro (BM) vs. macro (full thickness stromal folds)
 - Flap dislocation
 - Early (~1.4%) vs late (0.012%)

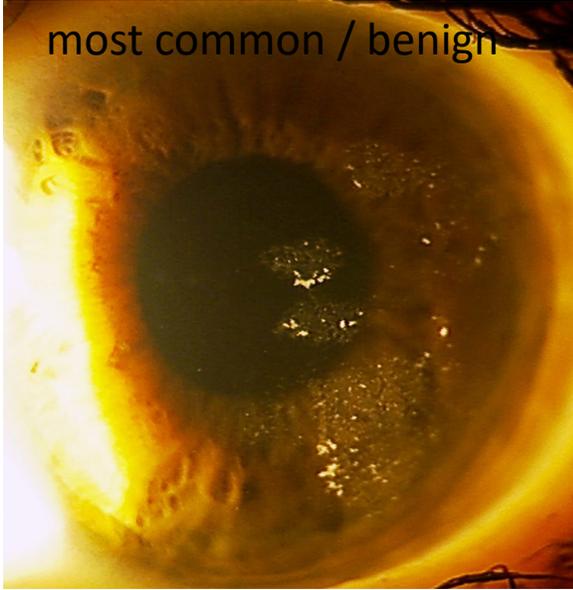


LASIK

- Techniques
 - Microkeratome
 - Laser
- Complications (both):
 - Diffuse lamellar keratitis (DLK)
 - Central toxic keratopathy (CTK)
 - Infectious keratitis
 - Pressure induced stromal keratitis (PISK)
 - Epithelial ingrowth

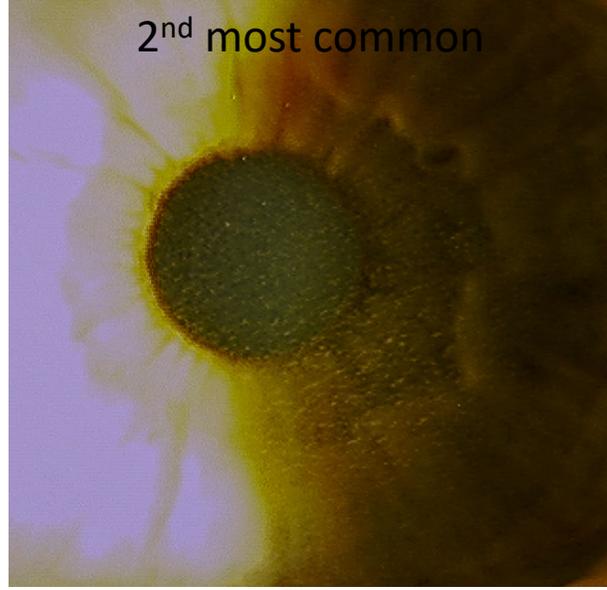
Interface debris

most common / benign



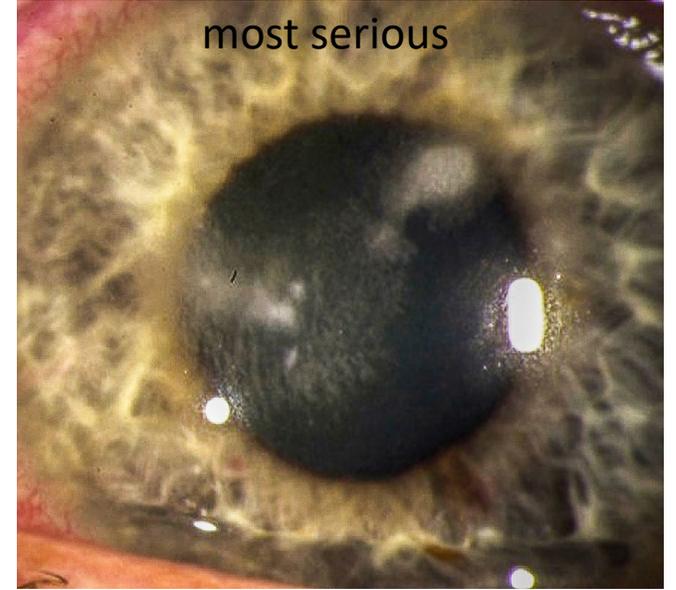
DLK

2nd most common



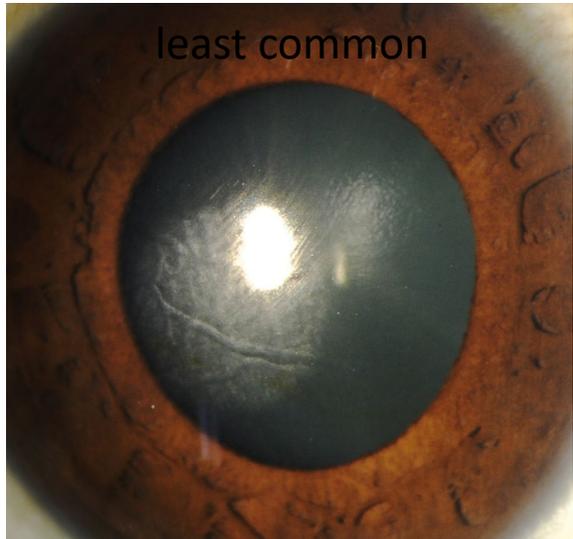
Infectious keratitis

most serious



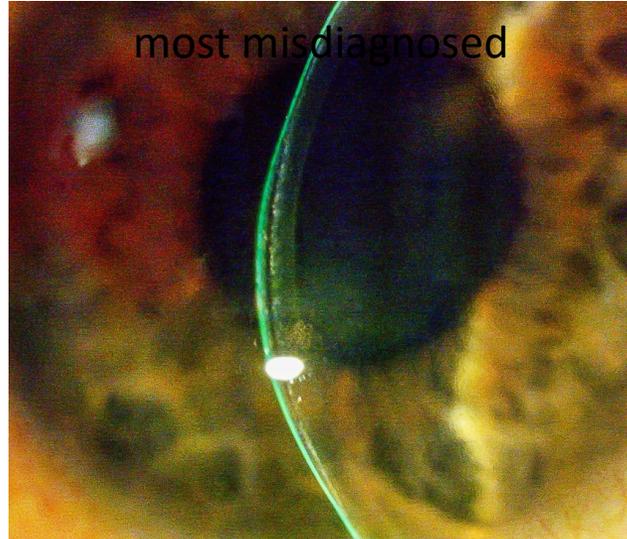
CTK

least common



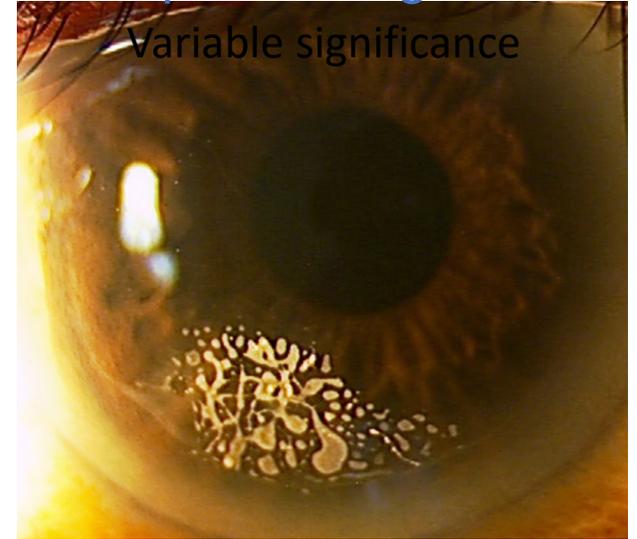
PISK

most misdiagnosed



Epithelial ingrowth

Variable significance

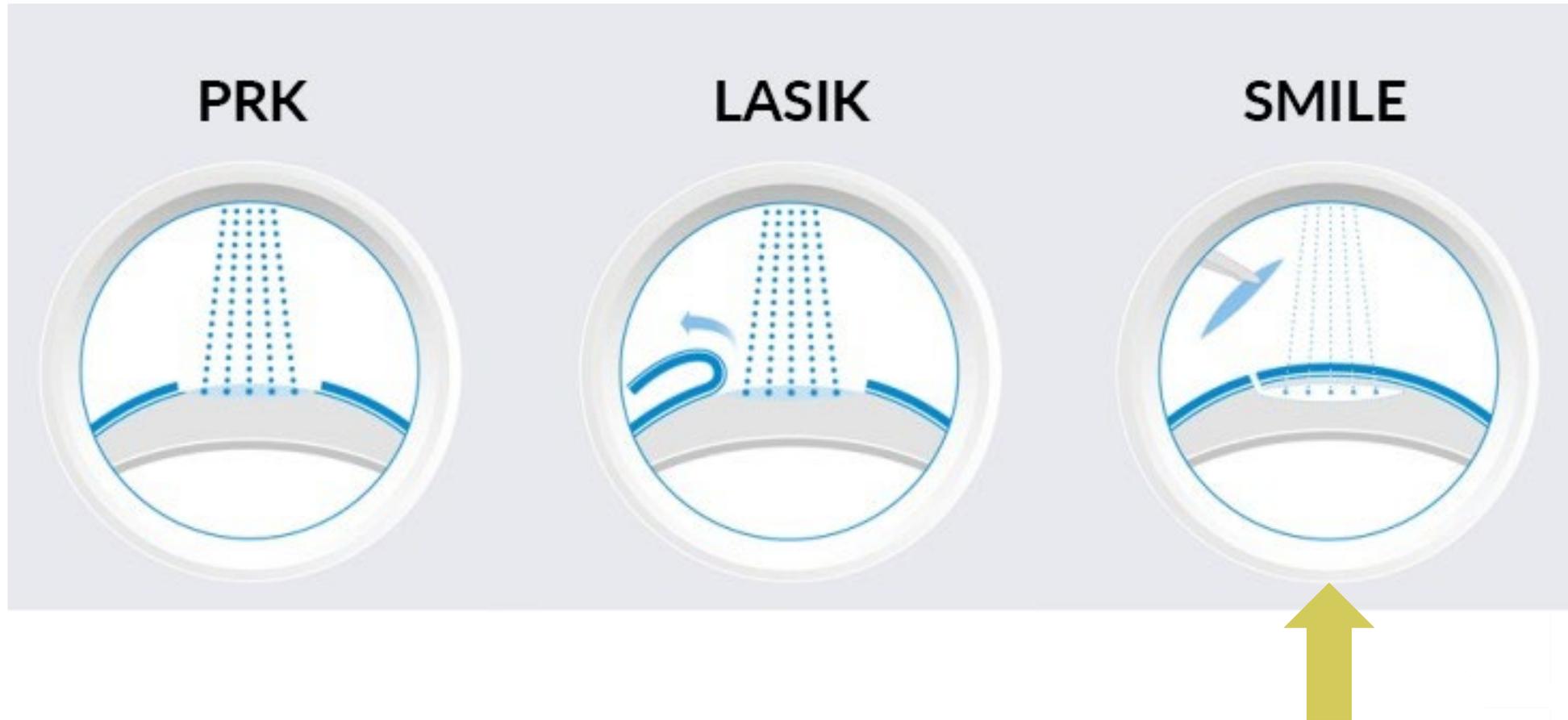


LASIK

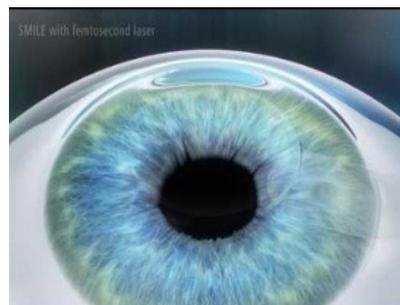
- Complications



SMILE



SMILE



SMILE

- SMILE-specific complications:
 - Suction loss
 - Irregular lenticule dissection/ removal
 - Cap perforation

Complications



Complications

- Infection
- Residual refractive error
 - 1-11% enhancement
- Optical aberrations (glare, halos, starburst)
 - More common with smaller optical zone (<6mm) and higher mrx
- Decentered ablation
- Dry eye
- Ectasia

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Complications (infection)

Table 5. Statistical comparison of microbial keratitis incidence between contact lens modalities and LASIK assuming 1 year, 5 years, and 10 years of contact lens wear and assuming a 10% retreatment or enhancement rate.

Comparison	1 Year			5 Years			10 Years		
	Rate Diff per 10 000	95% CI	P Value	Rate Diff per 10 000	95% CI	P Value	Rate Diff per 10 000	95% CI	P Value
Soft daily vs LASIK	-2.6	-4.7, -0.4	.0229	10.5	7.1, 13.9	<.0001	26.9	22.4, 31.3	<.0001
Soft extended vs LASIK	11.5	8.0, 15.0	<.0001	80.8	73.9, 87.7	<.0001	167.8	158.2, 177.4	<.0001
RGP vs LASIK	-4.7	-6.6, -2.8	<.0001	0.0	-2.5, 2.5	.9968	5.8	2.8, 8.9	.0005

CI = confidence interval; LASIK = laser in situ keratomileusis; RGP = rigid gas-permeable

PRK 0.01 – 0.8%; severe 1 in 7000

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Complications (refractive error)

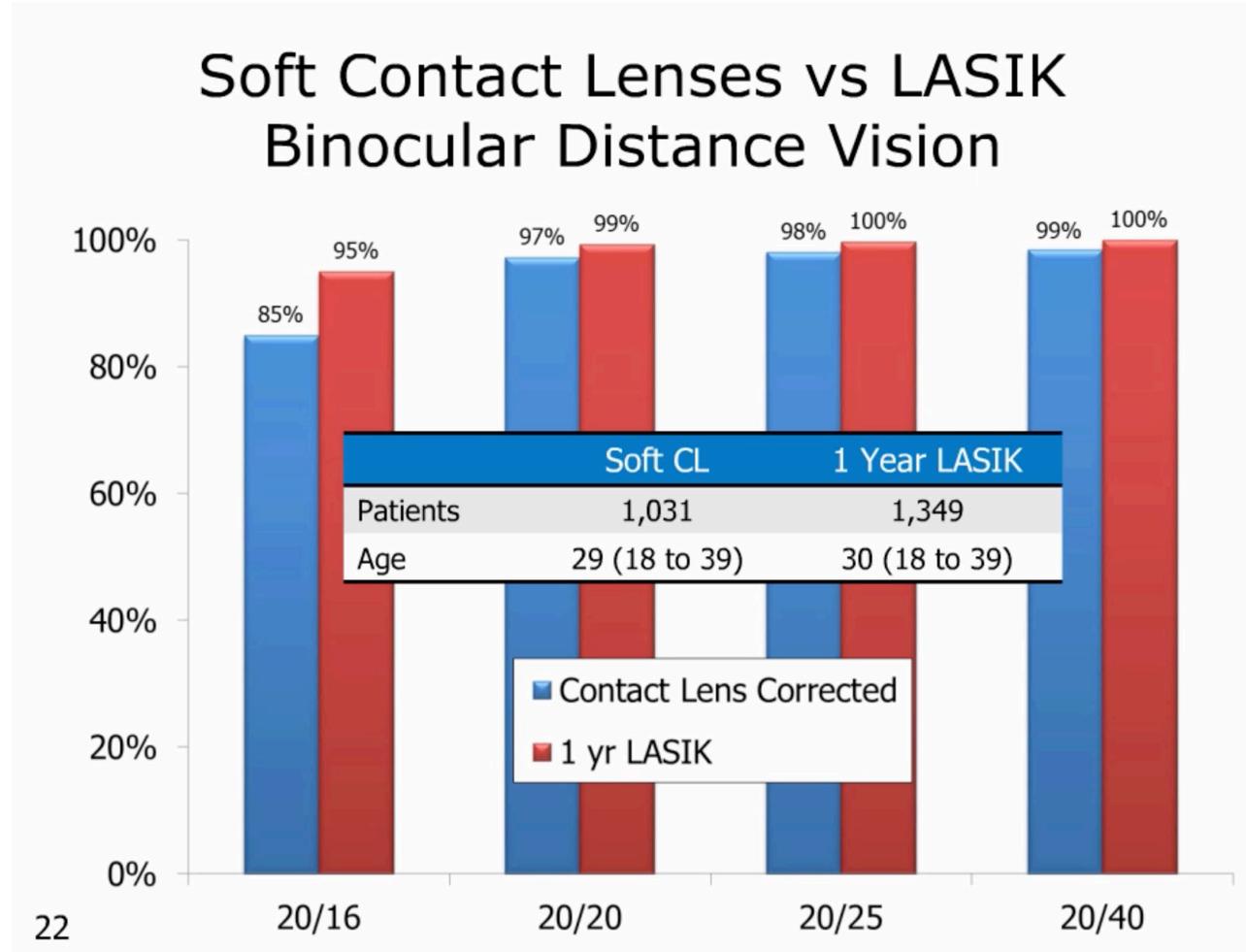
All JCRS articles (97) from 2008-2015 (56,000 eyes)

- 90.8% 20/20 or better
- 99.5% 20/40 or better

- 90.9% within 0.5D, 98% within 1.0D

- 0.61% lost 2 lines BCVA vs 1.45% gained 2 lines BCVA

Outcomes (LASIK refractive)

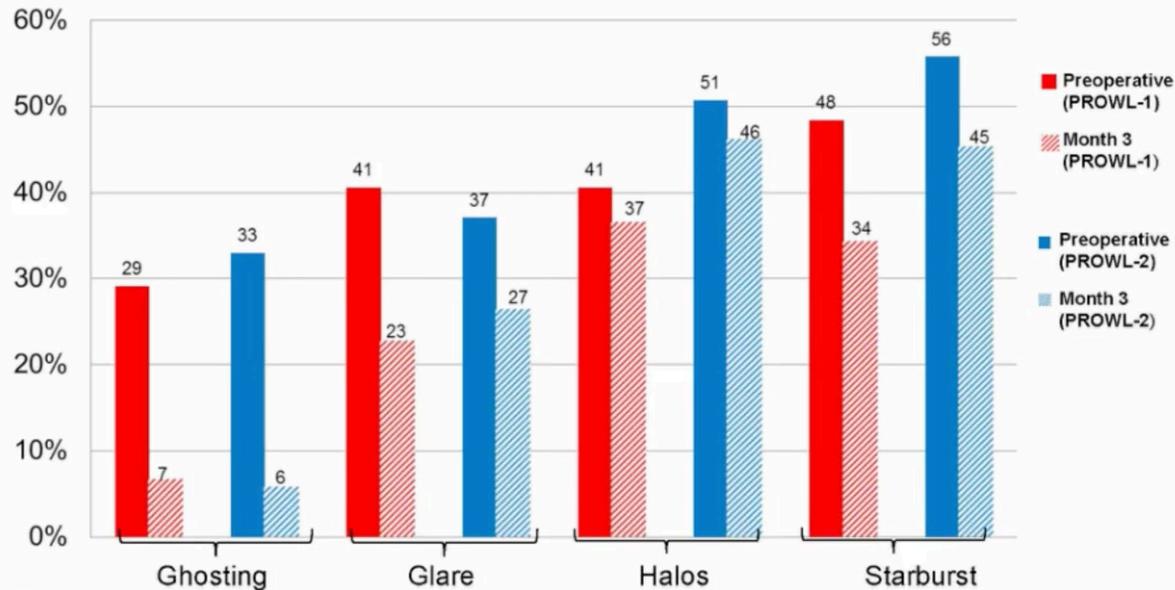


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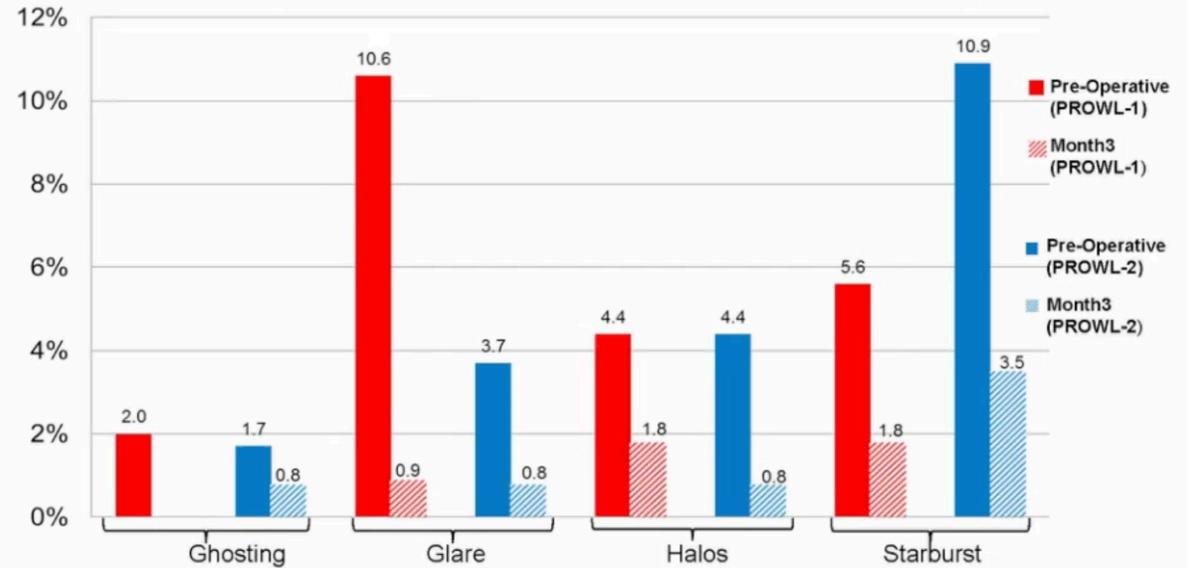
General Complications (glare)

Prevalence of Symptoms: Preoperative vs. Month 3



11 The prevalence of visual symptoms did not increase postoperatively

Prevalence of Bothersome (Very and Extremely) Visual Symptoms (Preop w/ correction, 3 Months – w/o correction)

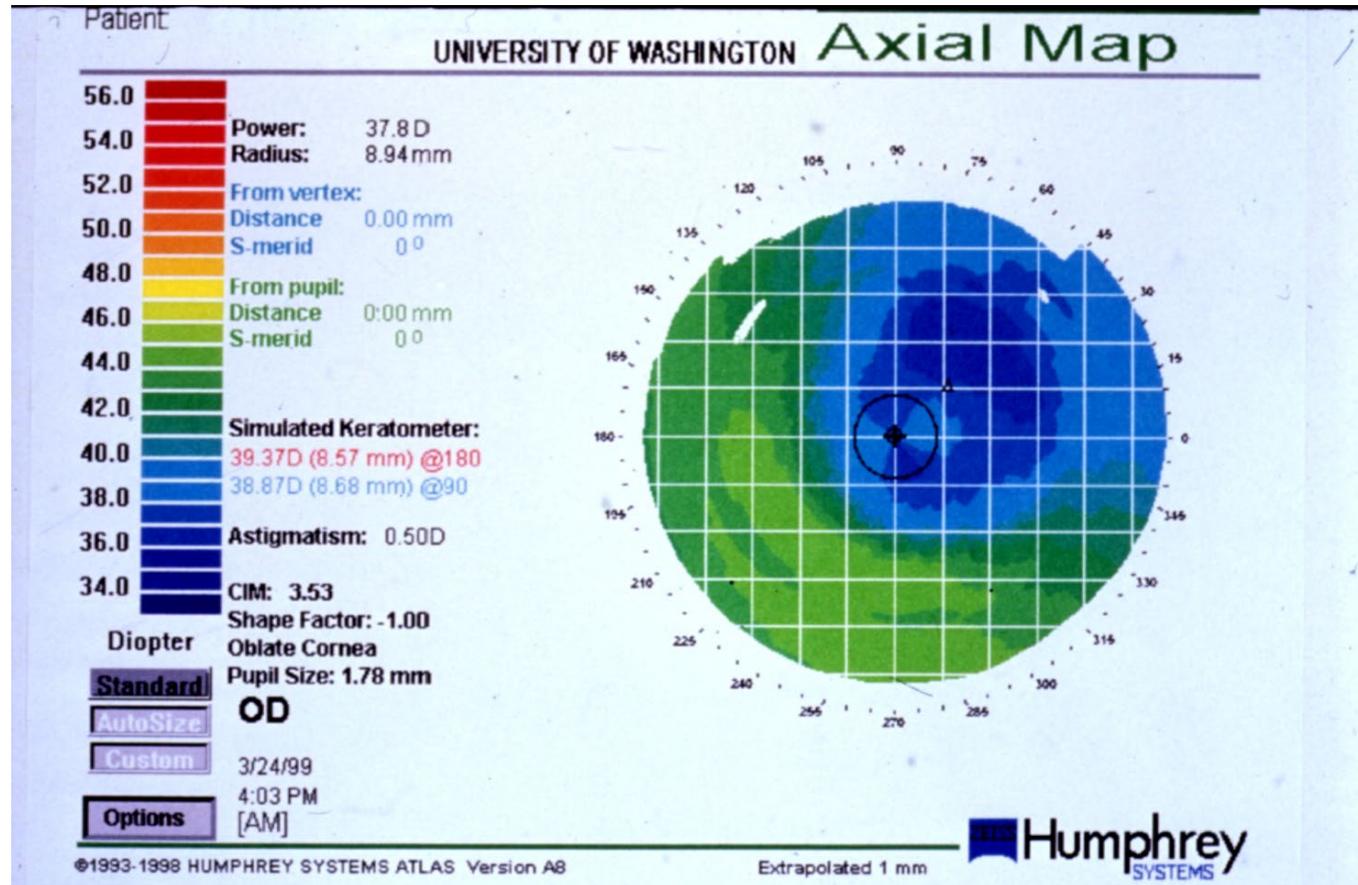


12 Visual symptoms were very or extremely bothersome in up to 4% of subjects without correction at 3 Months

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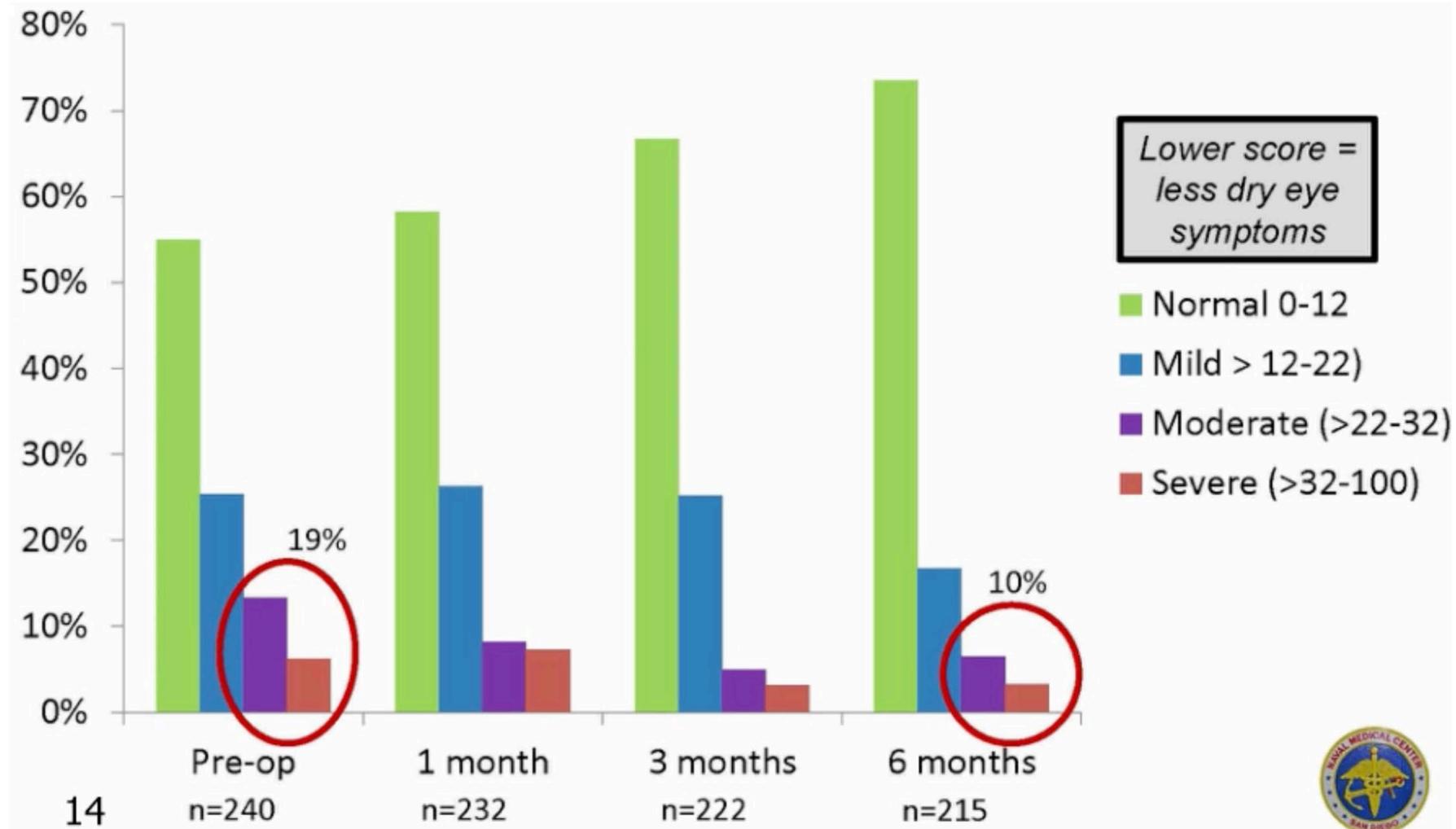
Complications (decentration)



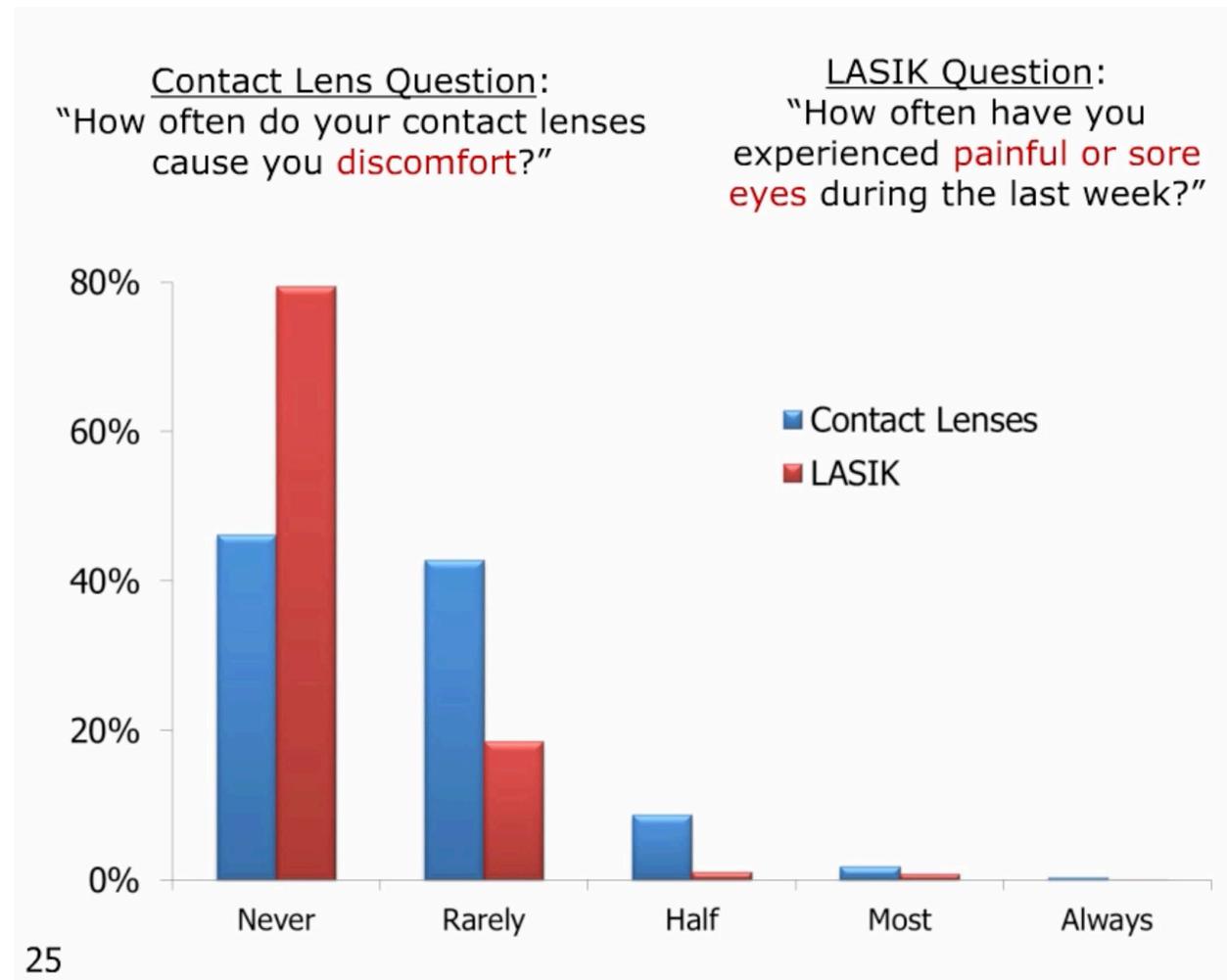
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Complications (dry eye)



Complications (dry eye)



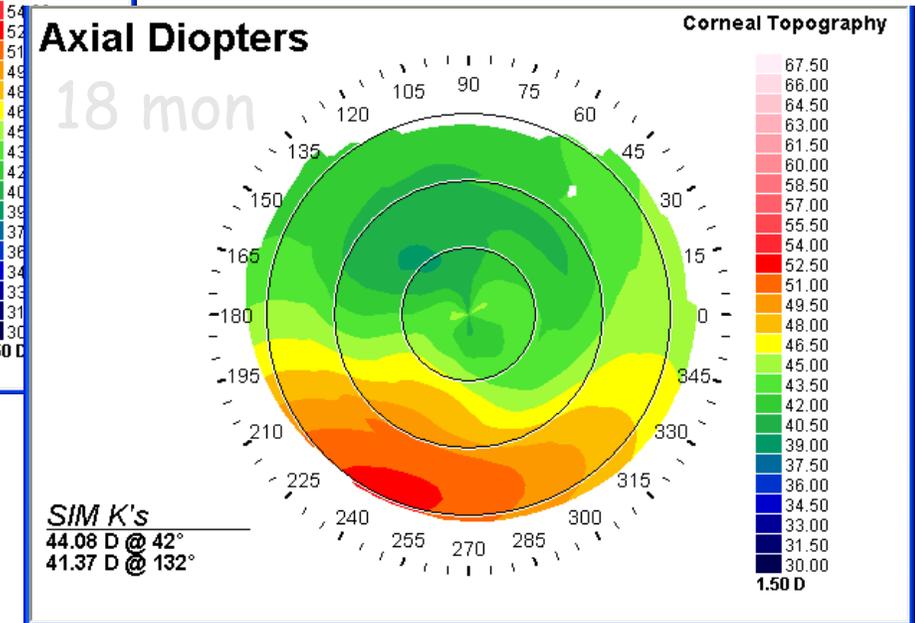
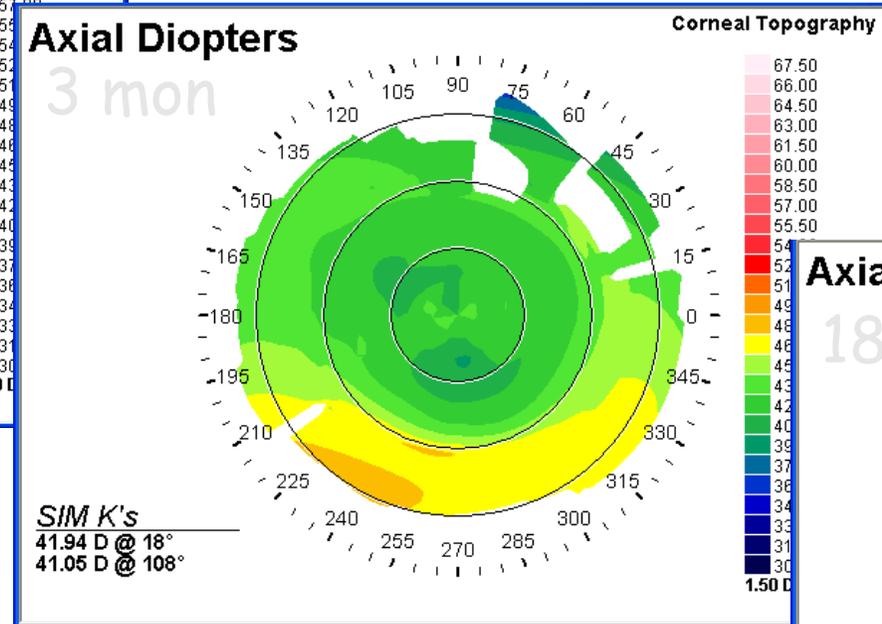
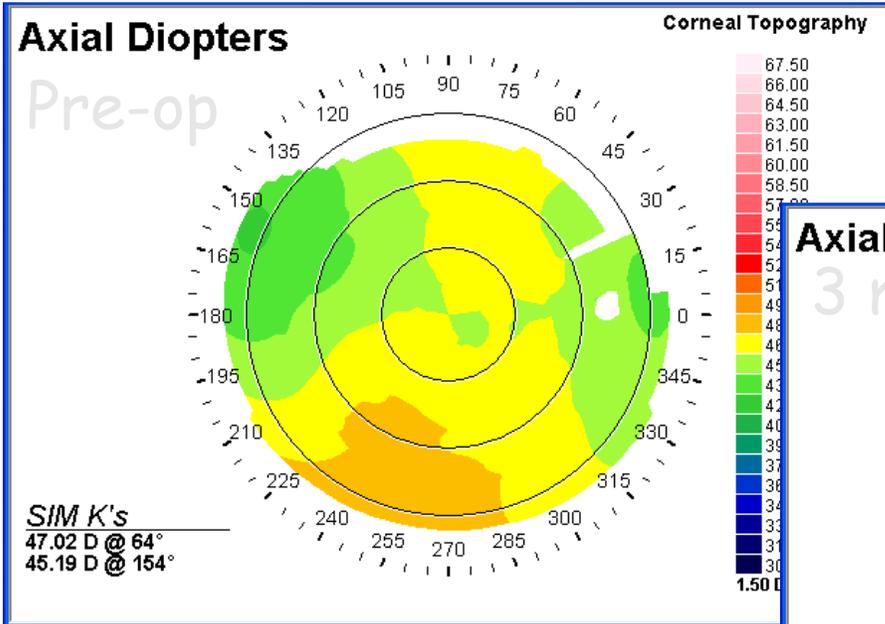
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Complications (ectasia)

- Risk factors:
 - Young age
 - High ablation /mrx
 - Thin cornea
 - Irregular pre-op curvature
- Incidence of post-refractive ectasia
 - PRK 0.011 - 0.029%
 - LASIK 0.013 - 0.935%

Complications (ectasia)



Outcomes (satisfaction)

Outcomes (satisfaction)

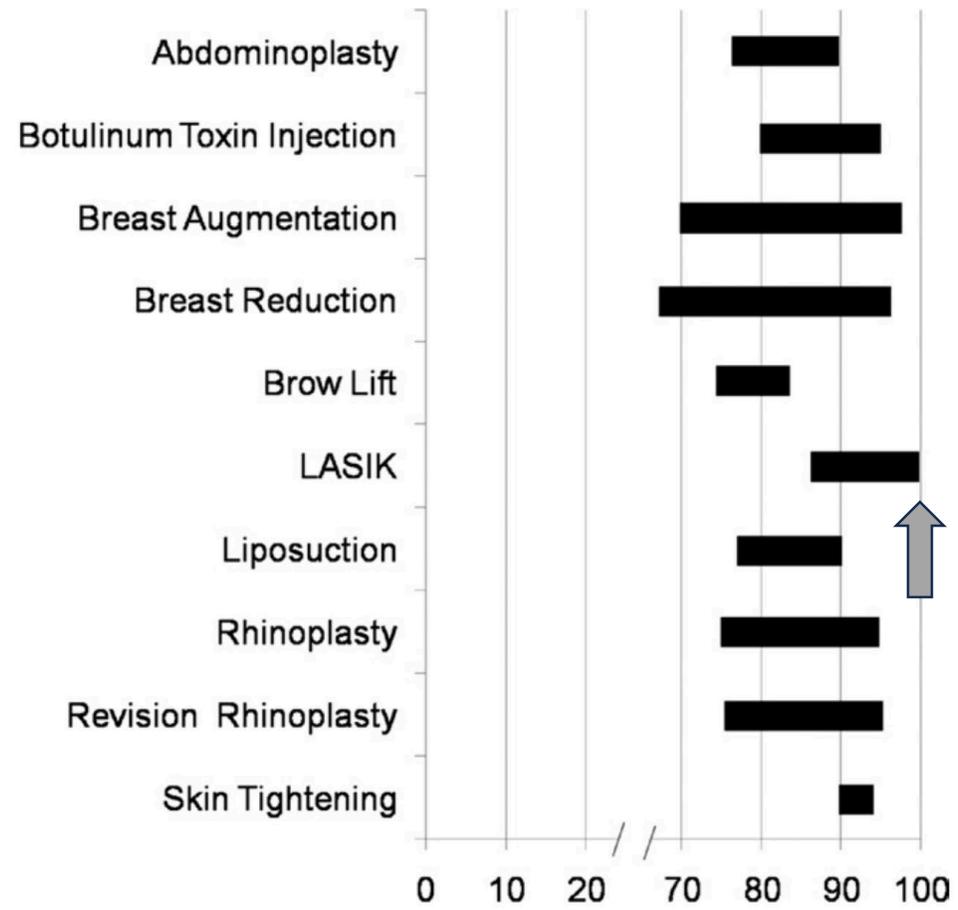


Figure 5. Percentage of patient satisfaction after different elective surgical procedures.

Summary

- Radial keratotomy (RK) 1970s
- Astigmatic keratotomy (AK)
- Onlay & Inlay
- Photorefractive keratectomy (PRK) 1980s
- Laser in-situ keratomileusis (LASIK) 1994
- Small incision lenticule extraction (SMILE) 2014

Summary

- Many options for achieving refractive goal
- Risks & benefit vary by procedure
- Tailor options to patient

Questions

