NEW OPTIONS FOR REFRACTIVE SURGERY

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DISCLAIMER & DISCLOSURES

As an Optometrist, I can

- **recommend and refer patients for surgery**
- **evaluate patients pre- and post-surgery**

but I *cannot*

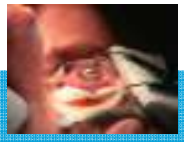
- **perform surgery**

CONFLICT OF INTEREST:

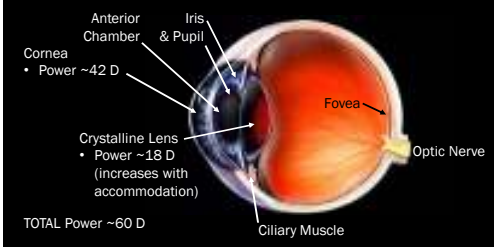
None; mention of any product or company does not constitute endorsement

WARNING:

Some images may make you feel uncomfortable



BASIC ANATOMY OF THE ADULT HUMAN EYE



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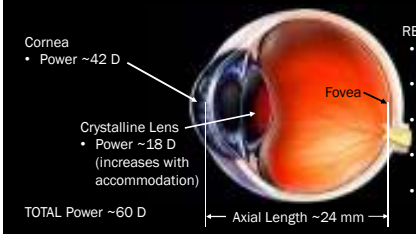


REFRACTIVE ERROR

- Emmetropia
  f'_{eye} falls *on* fovea
- Myopia
  f'_{eye} falls *in front of* fovea
- Hyperopia
  f'_{eye} falls *behind* fovea
- Astigmatism
  f'_{eye} *varies* with meridian
- Presbyopia
  Lens cannot accommodate

BASIC ANATOMY OF THE ADULT HUMAN EYE

Cornea (“*kerato-*”)
Total Thickness

- **Central ~550 µm**
- Peripheral ~650 µm

Central Thickness

- Epithelium ~50 µm
- ALM ~8 µm
- **Stroma ~490 µm**
- PLM ~3-20 µm
- Endothelium ~5 µm

BASIC ANATOMY OF THE ADULT HUMAN EYE

Crystalline Lens (“*phaco-*”, “*phaki-*”)
Axial Thickness: 0 Accom.

- Anterior Cortex ~0.5 mm
- Nucleus ~2.45 mm
- Posterior Cortex ~0.65 mm

TOTAL ~3.6 mm
Increases ~1.2%/yr

Axial Thickness: ~10 D Accom.
TOTAL ~4.0 mm

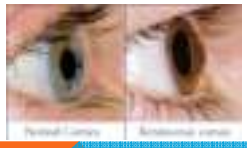
WHEN TO CONSIDER REFRACTIVE SURGERY

Refractive Error

- Typically no younger than 18 (more commonly, 20) years

Medical Conditions

- Keratoconus & Post-LASIK Ectasia (corneal thinning)
- Cataract



REFRACTIVE SURGERY GOALS

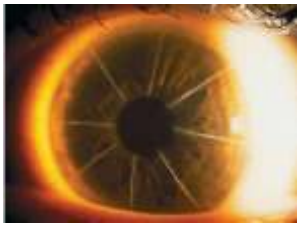
Make sure that the surgeon's goals are the SAME as your goals:

- With appropriate technique, most patients achieve VA of 20/40 or better
  - While 20/20+ may be *your* goal (or the surgeon's promise!), it may not be a realistic outcome of the surgery
  - *Monovision* (one eye corrected for far, the other corrected for near) can disrupt stereovision, depth perception – try with contact lenses BEFORE surgery
- Most patients have no or minimal complications.* Nonetheless, there can be:
  - Dry eye symptoms
  - Optical aberrations, e.g., halos, glare
  - Ectasia
  - Infection (rare)

*Surgeon should reveal how many and what type; be wary of "none"

"OLD SCHOOL" SURGERY

Radial Keratotomy (RK)



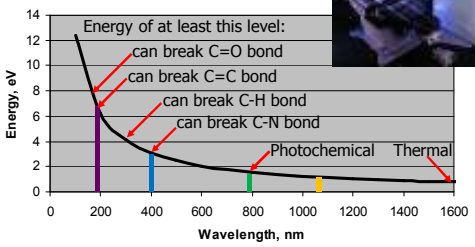
LASER REFRACTIVE SURGERY

Excimer Laser

- ArF laser emits at 193 nm

Femtosecond (FS) Laser

- Nd:YAG laser emits at 1053 nm



"TRADITIONAL" LASER PROCEDURES

"TRADITIONAL" LASER PROCEDURES

Laser-Assisted In Situ Keratomileusis (LASIK)

Refractive Error range

- Hyperopia to +6.00 D
- Myopia to -9.00 D
- Astigmatism to 6.00 D

Procedure

- Corneal flap
  - Microkeratome (blade): up to 200 µm thick OR
  - FS laser: as thin as 100 µm
- Ablation zone: 6-9 mm diameter
- Wavefront-guided reduces junctions at ablation zone

Complications

- Halos & glare if pupil diameter > ablation zone
- Dry eye symptoms, esp. with microkeratome flaps

"TRADITIONAL" LASER PROCEDURES

Photorefractive Keratectomy (PRK)

PRK

Refractive Error range
- Hyperopia to +6.00 D
- Myopia to -9.00 D
- Astigmatism to 6.00 D

Procedure
- Corneal epithelium removed
- Ablation zone: 6-9 mm diameter
- Wavefront-guided reduces junctions at ablation zone

Benefits
- Good for healthy – but thin – corneas
- Fewer dry eye symptoms

Complications
- Longer recovery – epithelium takes at least 24 hrs
- Halos & glare if pupil diameter > ablation zone

"TRADITIONAL" LASER PROCEDURES

Laser-Assisted (Sub-)Epithelial Keratectomy (LASEK)

LASEK

Refractive Error range
- Hyperopia to +6.00 D
- Myopia to -9.00 D
- Astigmatism to 6.00 D

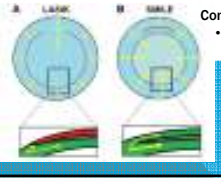
Procedure
- Corneal epithelium displaced (thinner flap, ~50 µm)
- Ablation zone: 6-9 mm diameter
- Wavefront-guided reduces junctions at ablation zone

Benefits
- Good for healthy – but thin – corneas
- Fewer dry eye symptoms

Complications
- Halos & glare if pupil diameter > ablation zone

LATEST LASER PROCEDURE

Small Incision Lenticule Extraction (SMILE)



Refractive Error range (approved in US so far)
- Myopia -1.00 to -9.00 D
- Astigmatism <0.50 D

Procedure
- FS laser carves a section of stroma that is removed through a small (2-4 mm) incision
- Ablation zone: 6-9 mm diameter

Benefits
- Good for healthy – but thin – corneas
- Fewer dry eye symptoms

Complications
- Halos & glare if pupil diameter > ablation zone

PHAKIC INTRAOCULAR LENS

Implantable Collamer Lens (ICL)

Refractive Error range
- Myopia -3.00 (Visian) or -5.00 (Verisyse) to -20.00 D (toric correction not available)

Procedure
- Crystalline lens remains in place
- Plastic lens placed in front of or behind iris
- Need sufficient anterior chamber depth (distance from cornea to iris)

Benefits
- Good for thin corneas, including keratoconus

Complications
- Cataract formation

CORNEAL INLAYS

AcuFocus Kamra

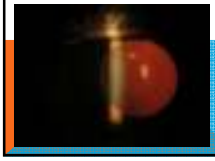
Refractive Error range
- Presbyopia
- Non-Dominant Eye: Myopia -0.75 to -1.00 D
- Dominant Eye: Emmetropia (may require add'l surgery)

Procedure (on non-dominant eye only)
- FS laser creates pocket 200 µm below surface
- Inlay – fenestrated plastic ring
  - 3.8 mm OD
  - 1.6 mm ID (i.e., pinhole effect!)
  - 6 µm thick

Benefits
- No corneal tissue removed
- Little or no discomfort, heals within days
- Reversible!

CORNEAL INLAYS

Revision Optics Raindrop



Refractive Error range
- Presbyopia +1.50 to +2.50 D add
- Non-Dominant Eye: Hyperopia +0.50 to +0.75 D
- Dominant Eye: Emmetropia (may require add'l surgery)

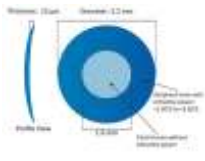
Procedure (on non-dominant eye only)
- FS laser creates flap ~150 µm thick
- Inlay – hydrogel (similar index to cornea)
  - 2 mm round
  - ~30 µm thick, varies with power

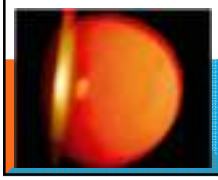
Benefits
- Reversible!

Complications
- Halos & glare
- Post-op flap complications similar to LASIK

CORNEAL INLAYS

Flexivue Microlens





Refractive Error range
- Presbyopia +1.50 to +3.50 D add

Procedure (on non-dominant eye only)
- FS laser creates tunnel in stroma
- Inlay – hydrogel (similar index to cornea)
  - 3.2 mm OD annulus with power
  - 1.6 mm ID plano center
  - 15 µm thick

Benefits
- Less effect on far vision than classic monovision approach
- Reversible!

Complications
- Not yet approved by FDA for use in US

POST-REFRACTIVE SURGERY ECTASIA

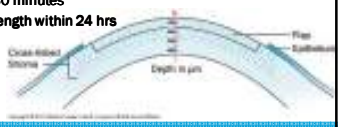
Corneal thinning/degeneration
- **Flap does not contribute to corneal strength**
- **Occurs a few weeks to 45 months post-op, average 13 months**
- **First described in 1998**
  - **RK/LASIK: Reported incidence 1/2,500 (0.04%) to 1/150 (0.66%)**
  - **SMILE: 4 cases reported (2017)**
- **Similar to Keratoconus, results in:**
  - **irregular astigmatism**
  - **increased HOAs (coma)**
  - **reduced Uncorrected and Best Corrected Visual Acuity**

POST-REFRACTIVE SURGERY ECTASIA

Risk factors following refractive surgery
- **Young age**
- **High myopia (>8 D)**
- **Reduced corneal thickness**
- **Thick flap (300 µm vs. 100 µm) = more biomechanical insult**
- **Higher amounts of ablation**
- **Thin residual stromal bed**
- **Pre-existing keratoconus**
- **Other corneal conditions, e.g., pellucid marginal degeneration**

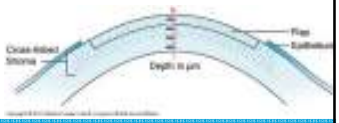
CORNEAL (COLLAGEN) CROSS-LINKING (CXL)

Procedure
- **Halts and partially reverses ectasia**
- **Originally developed and still used to treat Keratoconus**
- **Epithelium removed**
- **0.1% riboflavin-20% dextran T500 solution drops**
  - **Every 3 minutes for 30 minutes**
- **UV-A @ 370 nm applied for 30 minutes**
- **300% increase in tensile strength within 24 hrs**



CORNEAL (COLLAGEN) CROSS-LINKING (CXL)

Surgery Risks
- **Benign transitory haze**
- **Glare x3 months**
- **Corneal thinning up to 75 µm**
- **400 µm minimum before procedure**
- **Rare**
  - **Infectious keratitis**
  - **Herpes reactivation**
  - **Scarring**
  - **Sterile infiltrates**
  - **Acute melting and perforation**



REFRACTIVE LENS EXCHANGE (RLE)

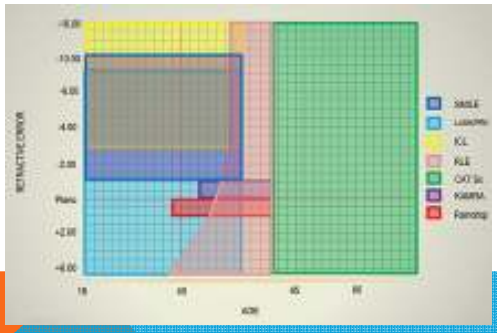
Intraocular Lens (IOL): usually for cataract (CAT), but also for very high myopia
- **Premium options**
  - **Toric IOL**
    - **Alcon AcrySof**
    - **STAAR**
  - **Multifocal IOL**
    - **Alcon AcrySof ReSTOR (diffractive): 3.2 D add**

REFRACTIVE LENS EXCHANGE (RLE)

Intraocular Lens (IOL): usually for cataract (CAT), but also for very high myopia

- **Premium options**
  - **Accommodative IOL**
    - **B&L Crystalens: flexes and moves with ciliary muscle contraction**
    - **AMO Tecnis Symfony (Extended Depth of Focus [EDOF])**
  - **Toric Multifocal IOL**
    - **AMO Tecnis Symfony Toric (diffractive/aspheric)**
    - **Alcon-Novartix ActiveFocus (EDOF)**
    - **B&L Trulign (similar to CrystaLens)**
- **Many surgeons offer LASIK, PRK, or Inlay with RLE**

REFRACTIVE SURGERY OVERVIEW GRID

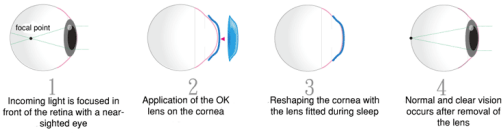


Courtesy of Kugler L, MD, and Sandberg, K, OD.

AND A NON-SURGICAL OPTION – FOR THE YOUNG. . .OR THE SQUEAMISH*!*

Ortho-Keratology (Ortho-K)

- **Approved ranges: Myopia -0.50 to -6.00 D; Astigmatism up to 1.75 D**
- **NO age restriction**
- **Minimal complications, completely reversible**
- **But NOT allowed for pilots (per FAA)**



RECAP

Have a lengthy conversation with your Eye Care Professional (OD or MD) AND Surgeon when considering surgery of any kind.

Get a COMPLETE eye examination, including full health check, before surgery.

FINALLY: WHY DO I STILL WEAR GLASSES?!?

I'm a presbyopic 2-D myope and this is my visual world most of the time!

THANK YOU!

QUESTIONS?
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