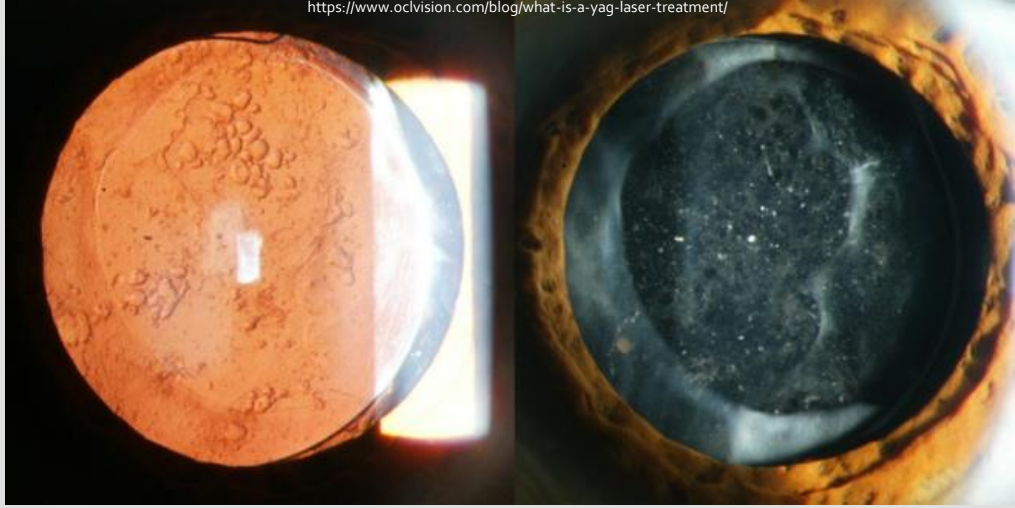
https://southerneye.co.nz/news/new-ellex-yag-laser-capability/


https://www.oclvision.com/blog/what-is-a-yag-laser-treatment/

Nd:YAG Laser Capsulotomy

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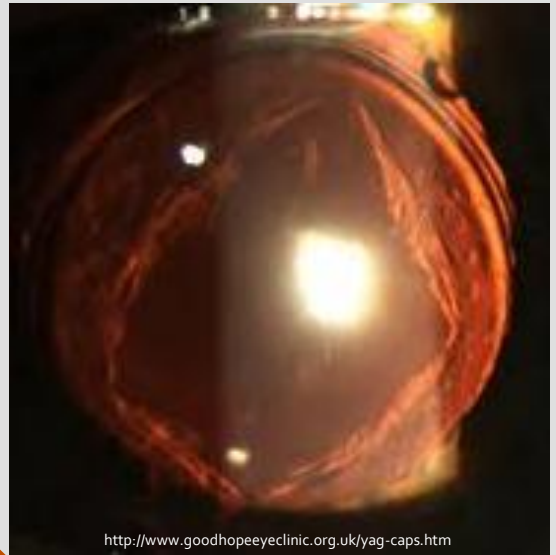
KENTUCKY COLLEGE OF OPTOMETRY


http://www.goodhopeeyeclinic.org.uk/yag-caps.htm


https://bceye.com/posterior-capsule-opacification-the-after-cataract/

Financial Disclosures:

- None

What makes a good surgeon?

- "Intelligence, professionalism, conscientiousness, creativity, courage, and perseverance on behalf of your patients are the critical factors, and they outweigh the small differences in dexterity among most medical students."

-American College of Surgeons

What makes a good surgeon?

- Specialist knowledge
- Good communication skills
- Bright eager mind, manual dexterity
- Extensive experience of pre and post operative care
- Ability to adapt and think on your feet
- Leadership skills
- Ability to inspire confidence in others
- Emotional resilience

-Royal College of Surgeons of England

Why learn how to do laser procedures?

Let’s get on with it…

Capsulotomy

- Before laser capsulotomy there was manual capsulotomy with a cystotome

Nd:YAG Capsulotomy

- Photodisruptive tissue interaction
- Lasers allow non-invasive techniques, enabling surgical intervention if a problem exists, which may be many years after time of cataract surgery

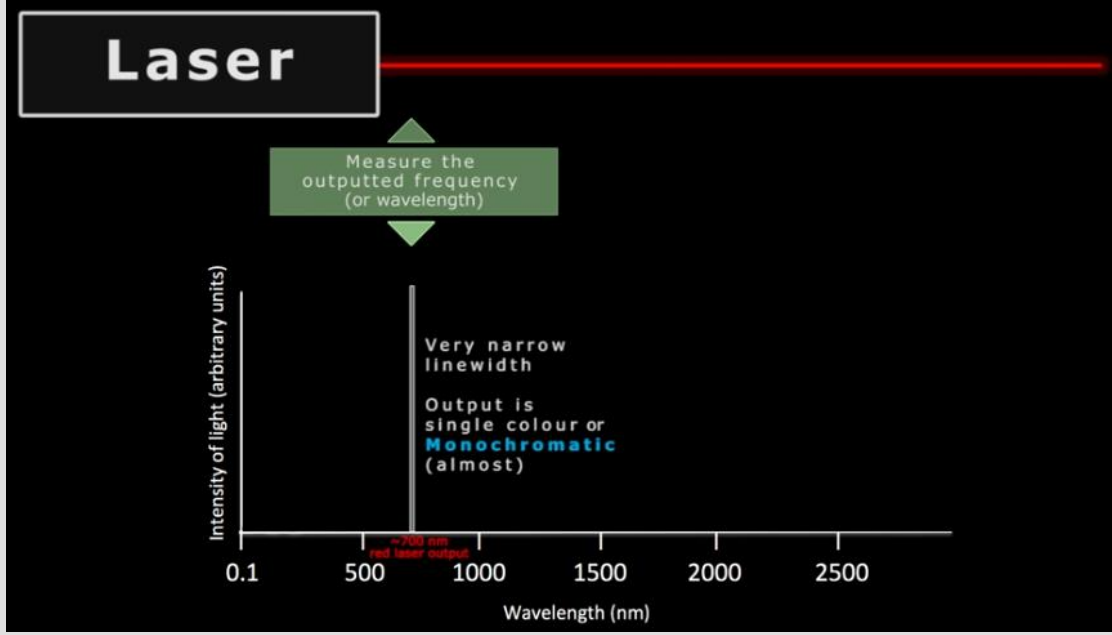
LASER

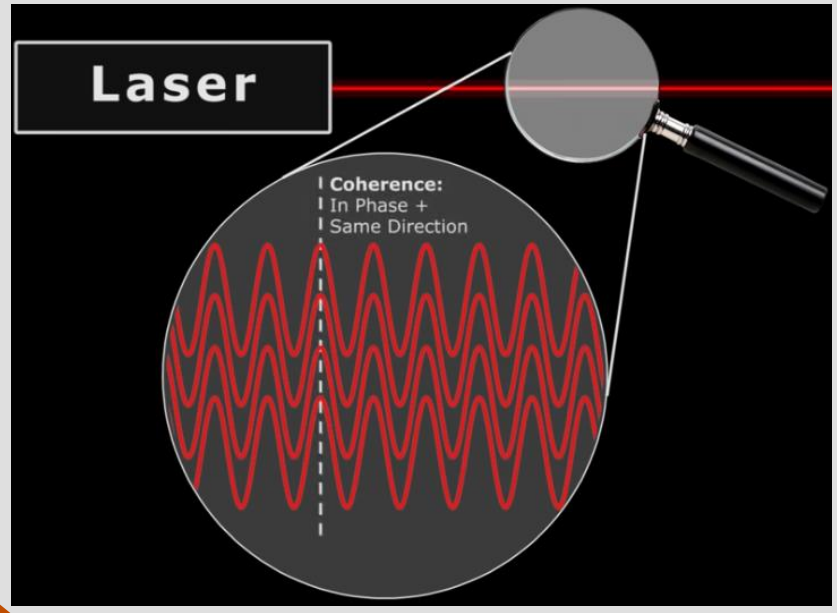
- Light Amplification by Stimulated Emission of Radiation

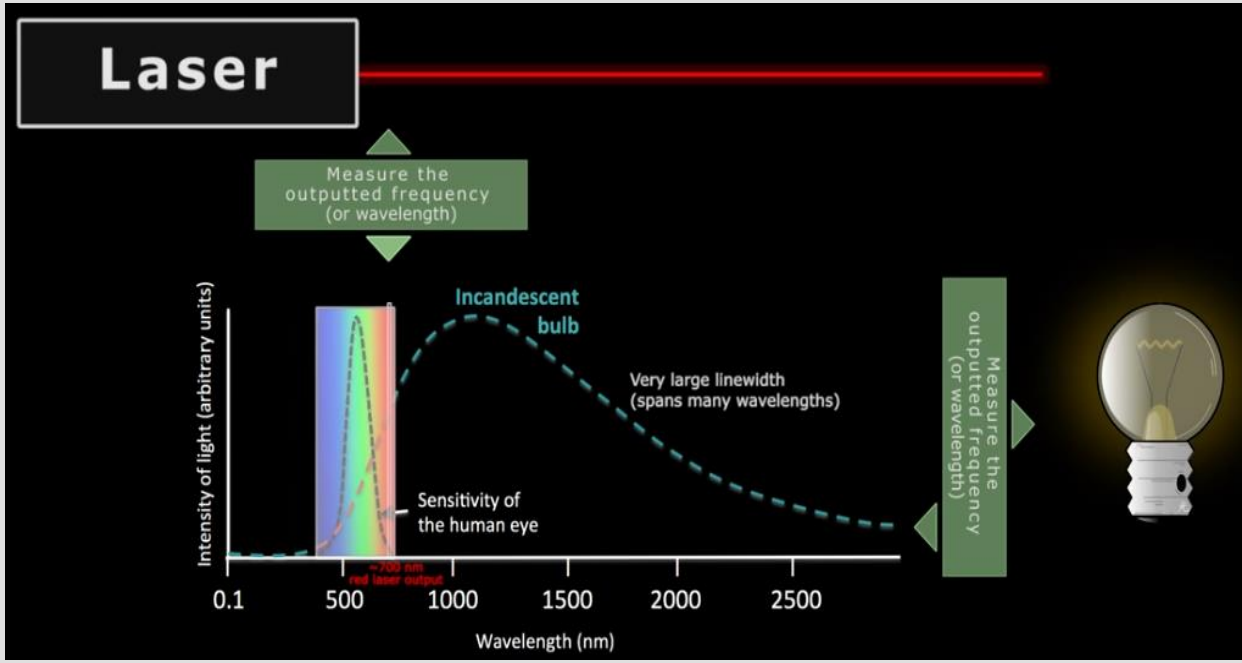
Some Basic Features

- Extremely narrow line width
- Monochromaticity
- Coherent and collimated light
- Energy output

- Nd:YAG laser output for capsulotomy has wavelength of 1064nm







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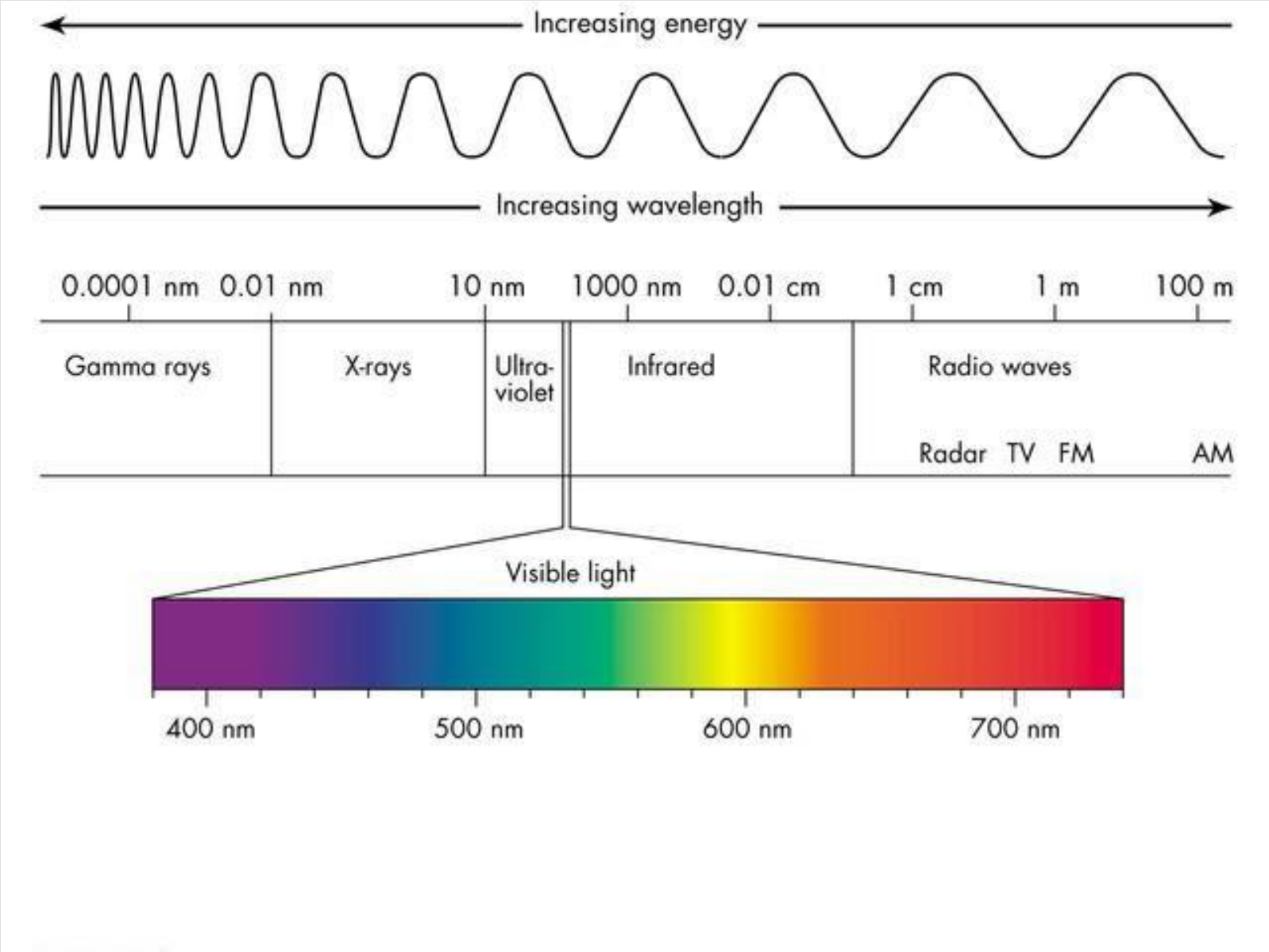


https://sites.google.com/a/coe.edu/principles-of-structural-chemistry/relationship-between-light-and-matter/electromagnetic-spectrum

3 Key Components as Discussed in Prior Lectures

- Stimulated absorption
  - Media is pumped with laser diode or flashlamp/tube = optically pumped
  - Neodymium doped yttrium aluminum garnet crystal
  - Excited state
- Spontaneous emission
  - Electrons fall from excited state to metastable state, then to other states/groundstate
  - Metastable state allows creation of population inversion
- Stimulated emission
  - Photon released during spontaneous emission during fall from metastable state interacts with another metastable state electron, causing emission of 2 photons in a packet
  - Packets of photons with same directionality, frequency, and coherence
  - Becomes the emitted light energy of laser

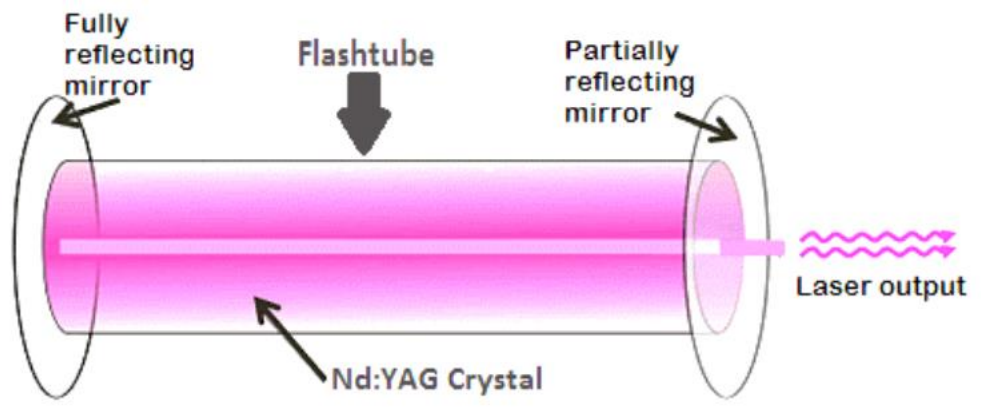
Output

- May be continuous or pulsed
- Pulsing may occur via several different mechanisms
  - Variable input from source
  - Q-switch
  - Mode-locking
- 1064nm – not visible
- Pulse duration 3-7ns
- Focused beam (16 degree cone angle)

Q-Switch

- Multiple forms and complexities
- It is a special modulator the prevents the ability to lase
- Prevents the population inversion from decreasing (returning to ground state)
- Therefore increases population inversion until a maximum is achieved
- Q-switch opens and a large pulse of energy is released in short time frame
  - Allows for milli, nano, pico, femto second durations, applicable to different laser techniques

Rudimentary Schematics of Continuous Wave Nd:YAG vs Short Pulsed Q-Switched Nd:YAG



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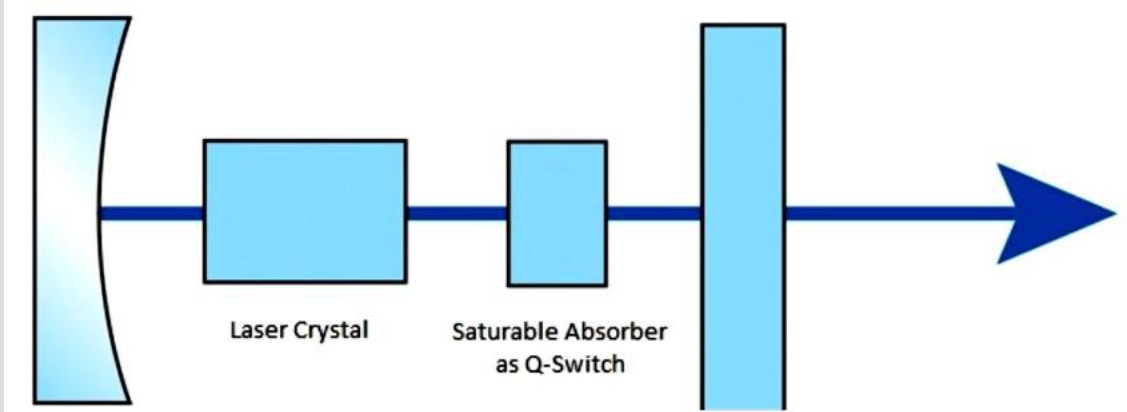


General Laser/Tissue Interaction

- Transmission
- Reflection
- Scatter
- Absorption

- Capsulotomy is pigment independent
- IR light has deep penetration

Optical Focus and Plasma Formation

- HeNe aiming beam
- Laser lens (Abraham lens)
- Concave mirrors and other optics of the laser converge the 1064nm wavelength photons on an infinitely small focal point
  - Fixed spot size of ~8 microns
- Dielectric breakdown and plasma formation
- Acoustic shockwave and photodisruption

Critical Focus

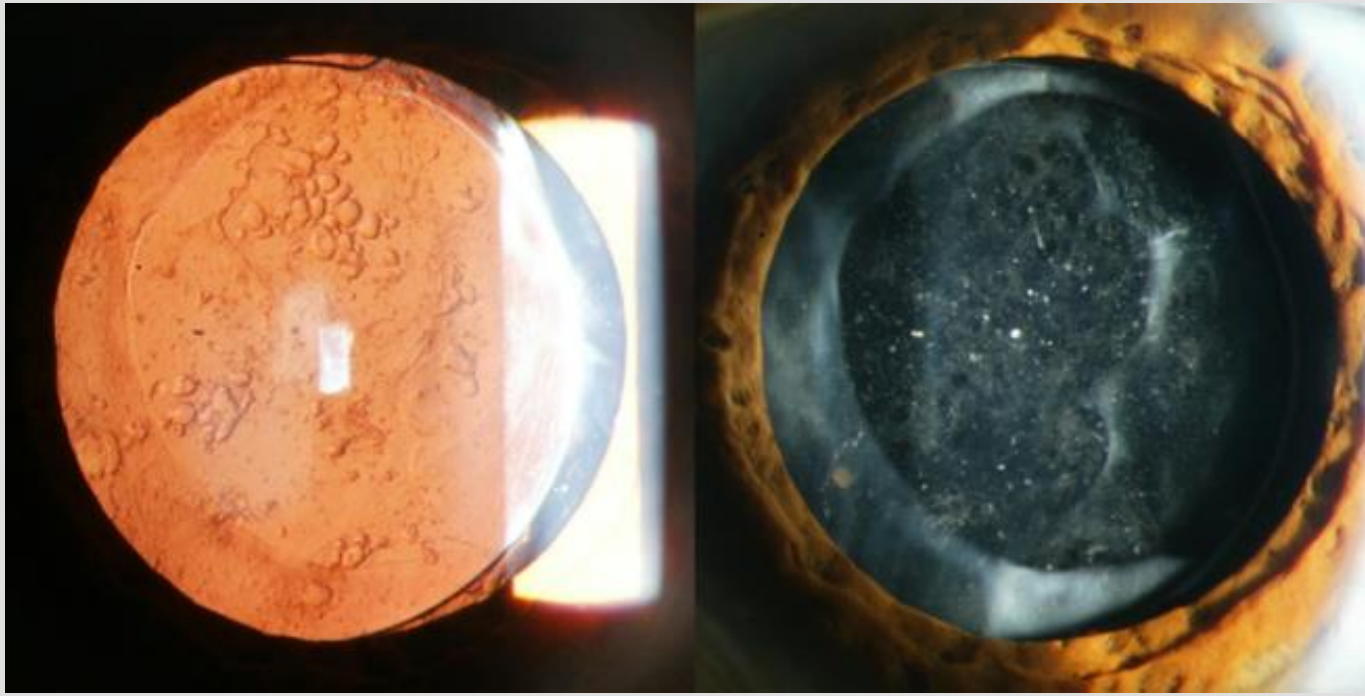
https://www.amazon.com/Abraham-Capsulotomy-Yag-Laser-Lens/dp/BooNTNZ85W

- Can have non-linear optical breakdown
- We want to work close to the plasma threshold at our focal point
- Suprathreshold, different interfaces/debris, and a smaller cone angle can influence unwanted plasma formation and a more anterior breakdown
- Larger cone angle localizes plasma near our focus

- Essentially the Abraham lens increases our cone angle and tightens up our focus
  - Leads to less optical breakdown of our laser beam while promoting plasma formation at our focus

Indication For Posterior Capsulotomy

- Posterior capsular opacification (PCO)
  - Associated with decreased visual acuity, glare, photophobia
  - Impairment of visual function (interferes with patient's needs and quality of life)



https://www.oclvision.com/blog/what-is-a-yag-laser-treatment/

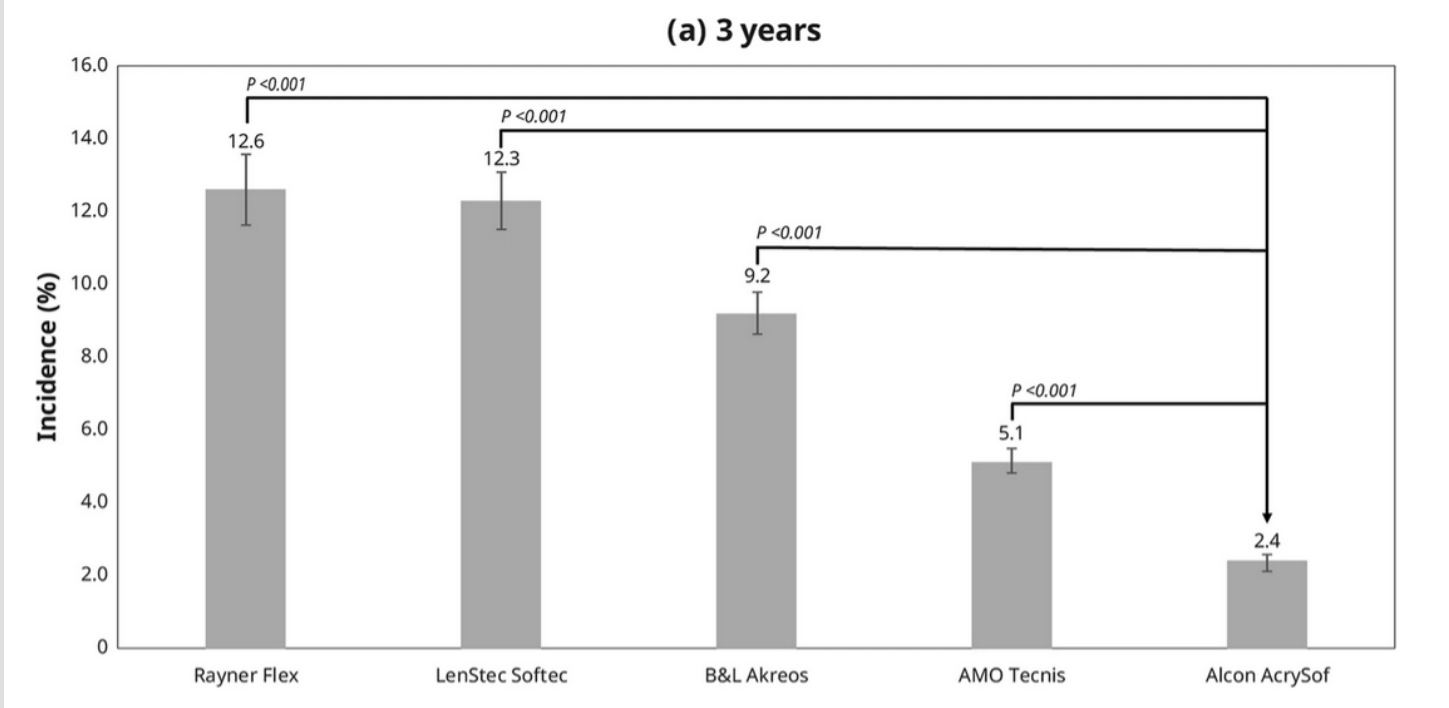
What is PCO?

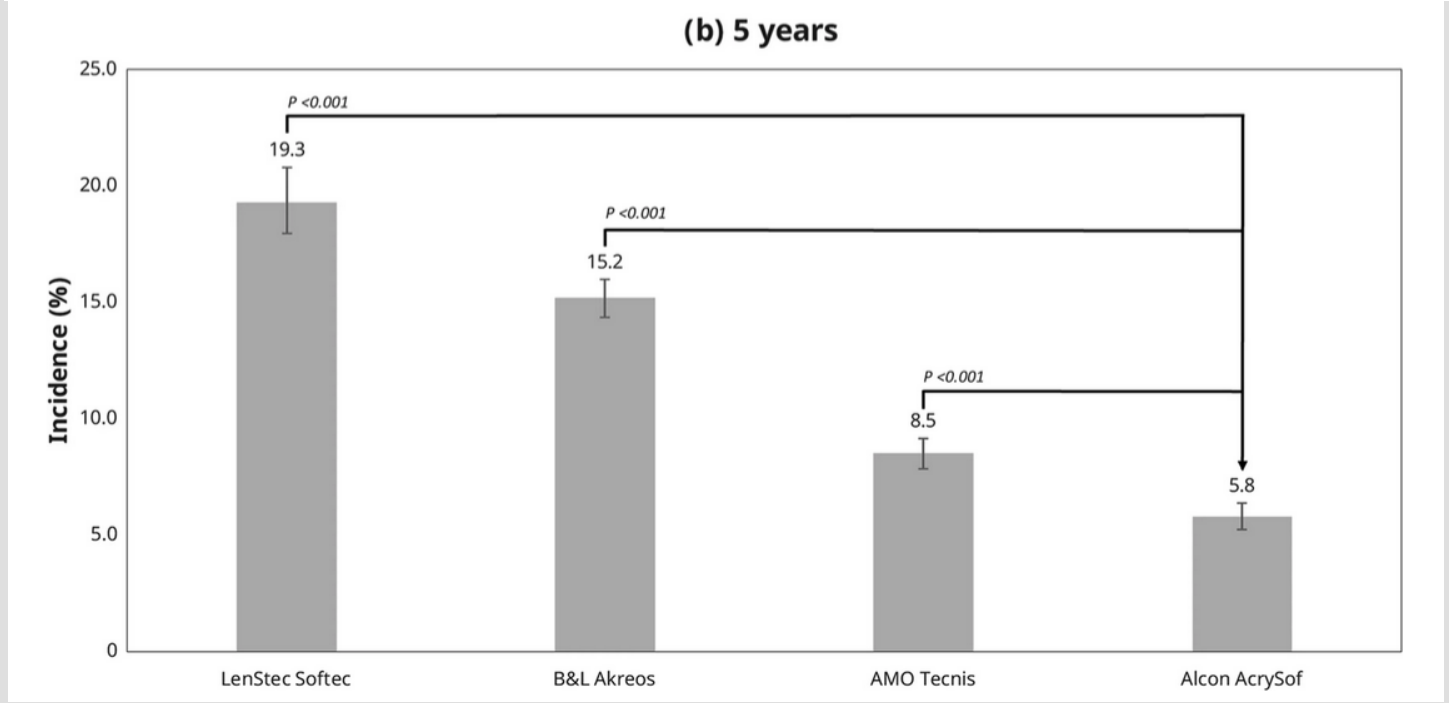
- Lens epithelial cells (LECs) leftover in capsular bag following cataract surgery
- Proliferation, migration, epithelial to mesenchymal transition (EMT), collagen deposition, and lens fiber regeneration mechanisms
- 2 Types of PCO
  - Fibrous
    - LECs proliferate and migrate, undergo EMT and fibrous metaplasia
    - Causes wrinkles/folds in posterior capsule
  - Pearl
    - Equatorial LECs cause regeneration of crystallin expressing lenticular fibers, forms Elschnig pearls and Soemmering's ring
    - Most common form of PCO

https://www.google.com/url?sa=i&url=http%3A%2F%2Fmetricjournal.co.uk%2Findex.php%2FMETRIC%2Farticle%2Fdownload%2F58%2F60&psig=AOvVaw2q_AmVxTPAqLkutmVnNlKE&ust=1600108477943000&source=images&cd=vfe&ved=0CAMQjB1qFwoTCNiUseDisusCFQAAAAAdAAAAABAJ

Incidence?

- Dependent on implant type, surgical experience, level of surgical complication, materials used during surgery





https://www.nature.com/articles/s41433-019-0630-9/figures/1

Contraindications For Procedure

- Uncontrolled IOP
- Inadequate visualization of target
- Inadequate stability of the eye
- No potential for improvement in vision post procedure
- Uncooperative patient

Other Considerations

- Recall the Abraham lens
- We discussed its optical benefit
- It also is extremely useful in controlling the patient
  - Keeps their eye open, maintains reasonable fixation
- Acrylic lenses tend to pit more, silicone lenses tend to develop PCO more

Pre-operative

- Your standard eye exam
- History
  - When cataract surgery, IOL type, complications?
- Entrance testing
- Refract
- Slit lamp
  - Look at pupil size prior to dilation and what PCO is present in the visual axis
- IOP
- DFE
  - Determine retinal stability, evaluate vitreous stability, look for vitreous strands/adhesions to IOL, PVD?, inflammation?
- Macular OCT recommended
  - Fully assess macular profile looking for foveal irregularity, current or prior maculopathy

Pre-operative

- Informed consent*
  - Educate the patient on what the procedure is, why we are doing it, what outcome to expect, risks and benefits of doing/not doing the procedure, alternative procedures, and complications
- Dilate with 1% tropicamide and consider 2.5% phenylephrine if needed
- 1 drop of brimonidine in operative eye 15-30 minutes prior
- 1 drop of proparacaine in operative eye and fellow eye

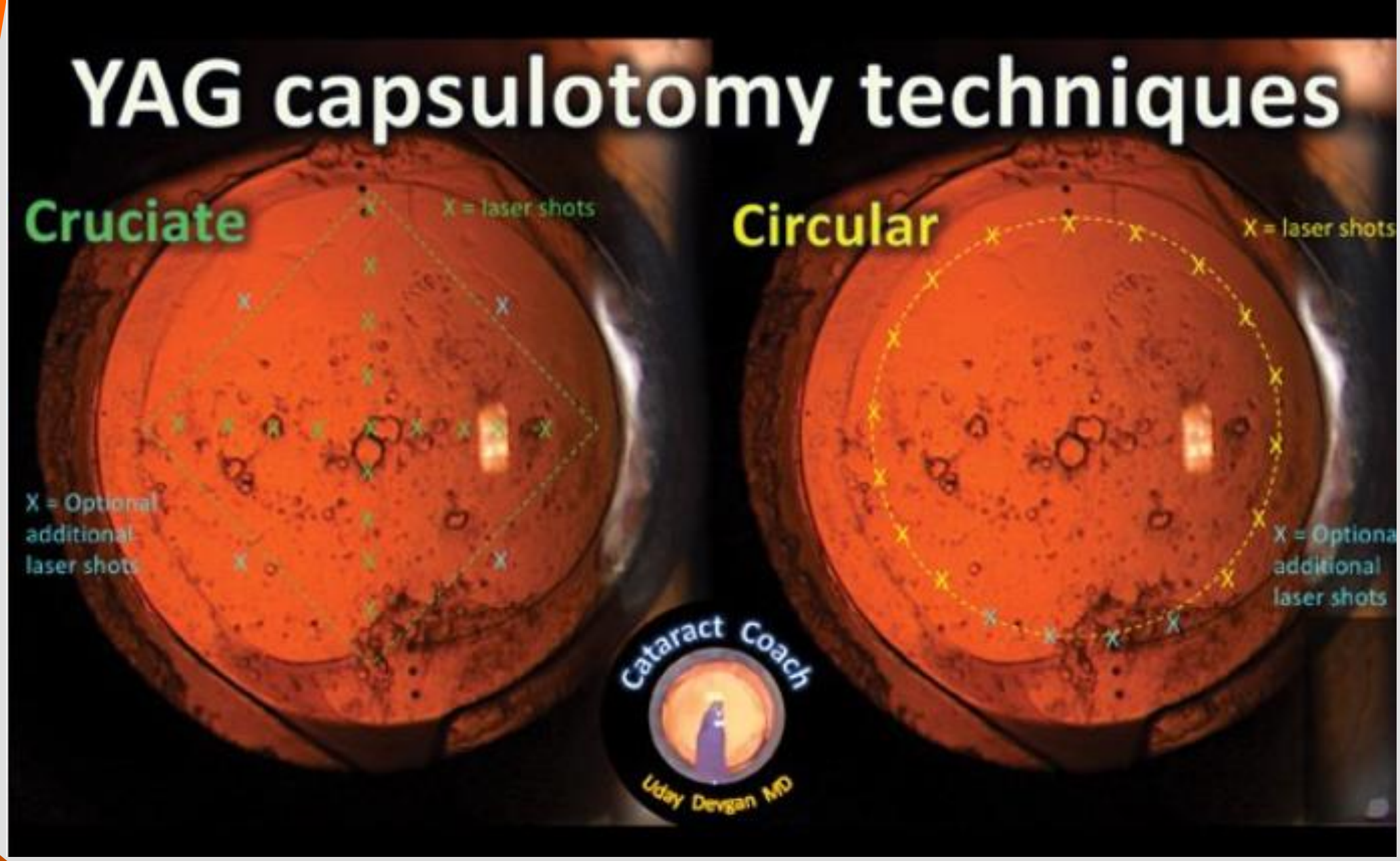
- Use Genteal Gel, Celluvisc, Goniosol etc. as lubricant for Abraham lens
- Educate the patient on what do expect during the procedure

The Procedure

- Laser settings:
  - Energy settings vary depending on thickness and extent of opacity
    - Initial energy may range from 0.8-2.5mJ
    - We typically start at, and recommend staying within, 1.0-2.0mJ and adjusting from there based on laser/tissue interaction
  - Spot size is fixed, about 8microns
  - Pulse duration, 3-7ns
  - 1 pulse
  - Offset is 125-500 of posterior offset, most commonly 250microns

The Procedure

- Focus HeNe beams (touching as close as visually possible) on target of interest
- Fire laser and observe tissue interaction
- If interaction is adequate, continue procedure
- If interaction is not adequate, adjust focus and/or energy settings and continue
- We want capsulotomy size to be larger than pupil size in normal dim conditions (before pharmacologic dilation)
  - Approximately 4-5mm in diameter, do not extend capsulotomy beyond diameter of IOL edges (IOLs are typically 6mm in diameter)
  - Keep at 4mm if Cyrstalens
- Perform cruciate or circinate pattern
- Ensure remaining corners/edges/vitreous adhesions are not obstructing visual axis and surrounding areas
- Procedure is completed, evaluate your work before leaving laser



https://www.healio.com/news/ophthalmology/20180921/two-techniques-effective-for-yag-laser-capsulotomy

Post Operative

- May need to rinse or clean eye
- 1 drop of brimonidine in post surgical eye
- Recheck visual acuity and IOP 30 minutes post procedure
- Rx prednisolone acetate 1gtt QID in post surgical eye for 1 week
- Educate patient on signs and symptoms of complications
- Schedule patient for 1 week follow up and tell them to RTC sooner if they note decline in vision or comfort
- Record number of total pulses, total energy used, which eye procedure was done on, and how well the patient tolerated the procedure in your EHR chart

Follow-up

- At 1 week follow up, perform you standard eye exam as you did the first time
- Look closely for inflammation and retinal complications on your DFE
  - Refraction is optional if you are performing the procedure on the fellow eye today and you refracted the fellow eye 1 week ago
  - Consider refraction if pinhole acuity is reduced regardless
- If all is well, d/c prednisolone acetate, release back to referring doctor

Complications

- IOP spike – most common, ~12.6%
- Inflammation – second most common, ~ 9.9%
- IOL damage – Pits, ~7.8%
- Floaters – not assessed in study, probably most common benign problem
- CME – rare, ~2.9%
- Retinal detachment – rare, ~2.3%

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- Thanks