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BUSINESS of REFRACTIVE CATARACT SURGERY

SUMMIT

The Surgery of Advanced Implants

William F. Wiley, MD

Disclosure

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- Alcon
- Zeiss
- JNJ
- Lensar

What Makes Advanced Implants Unique

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- We are dealing with a premium patient base
- High expectations
- Short-term and long-term IOL stability
- Potential for IOL exchange
- Minimal margin for error

"BASIC" Cataract Surgery

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- Lower expectations
- If lens moves and the prescription changes… just change the glasses
- Can yag at any time without consequence

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How is my surgery different?

Advanced Implant Surgery

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- Lens Stability
- Lens Positioning
- Astigmatism Correction
- Capsule/Yag Laser
- Other thoughts

Short and Long Term IOL Stability

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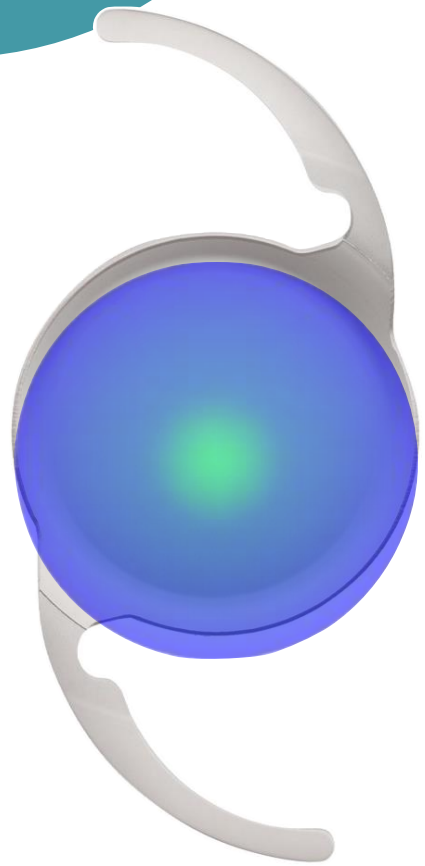
A lot of energy goes into picking type of premium IOL

We spend all this time and energy in picking the IOL

Critical to assure the proper lens power is used

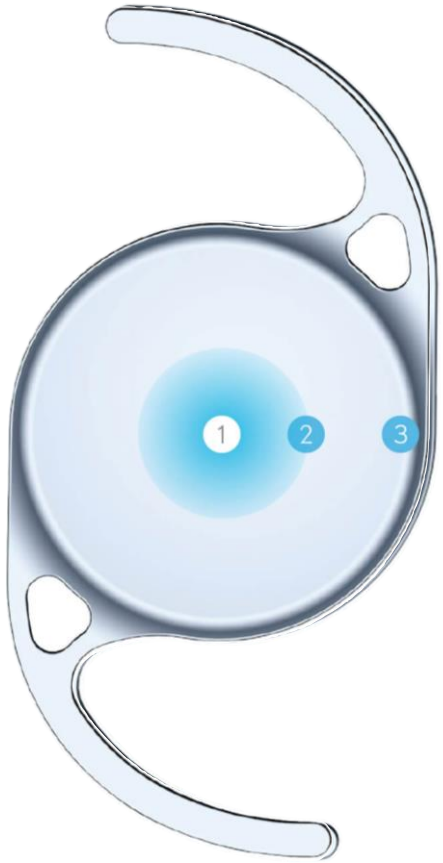
But choice of IOL is just the beginning

?



Eyhance®

(Central ⊖SA)



Aspire®

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RayOne EMV®

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Proper IOL Placement

Why do we surgeons use advanced tools and techniques?

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1

To help assure short and long-term stability

2

Allow for the fastest healing and recovery

3

Help maximize the investment patients are making

Key aspect is proper Capsule/Lens Overlap

Stability and Performance

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- **Lens will be more stable long term when rhexis is symmetric**
- **Optic performance better if IOL centered on visual axis**

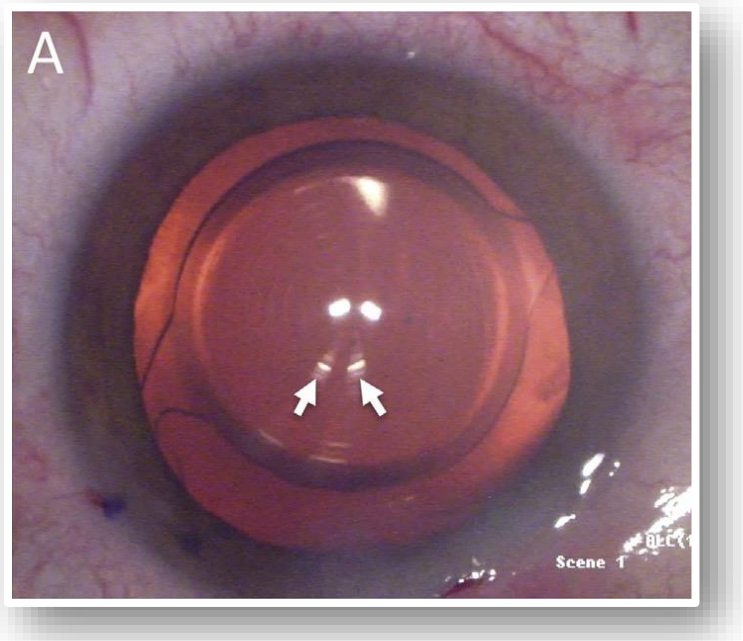
Thankfully both tend to be the same location:

I have found that the center of the bag tends to align with the center of the visual axis

Implant Surgical Goal

Goal

A. IOL centered

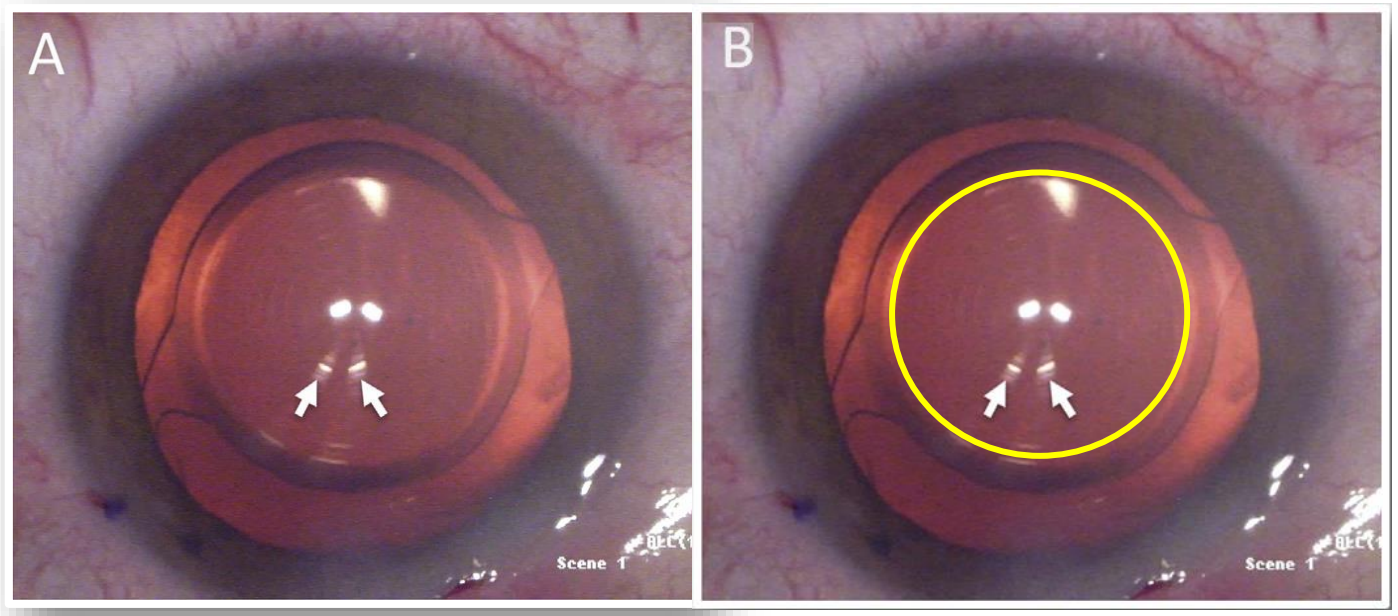


Implant Surgical Goal

Anatomic and Optical Goal

A. IOL centered

B. Capsulotomy Centered 360° overlap of anterior capsule over the optic

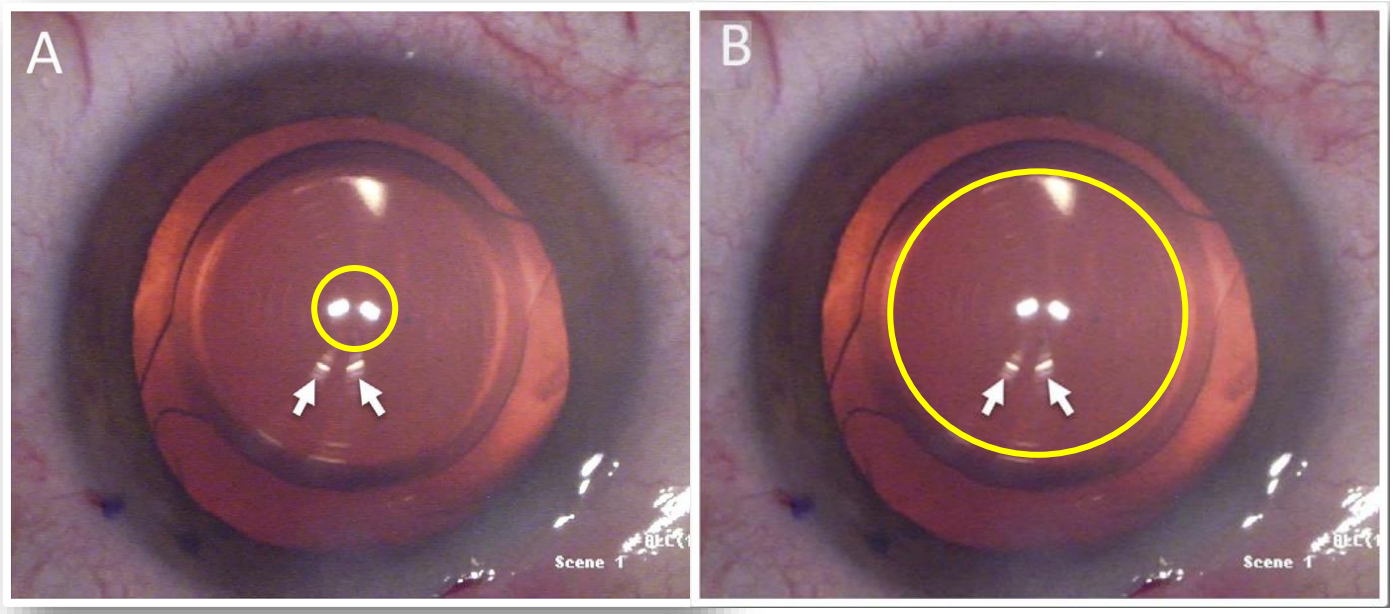


Implant Surgical Goal

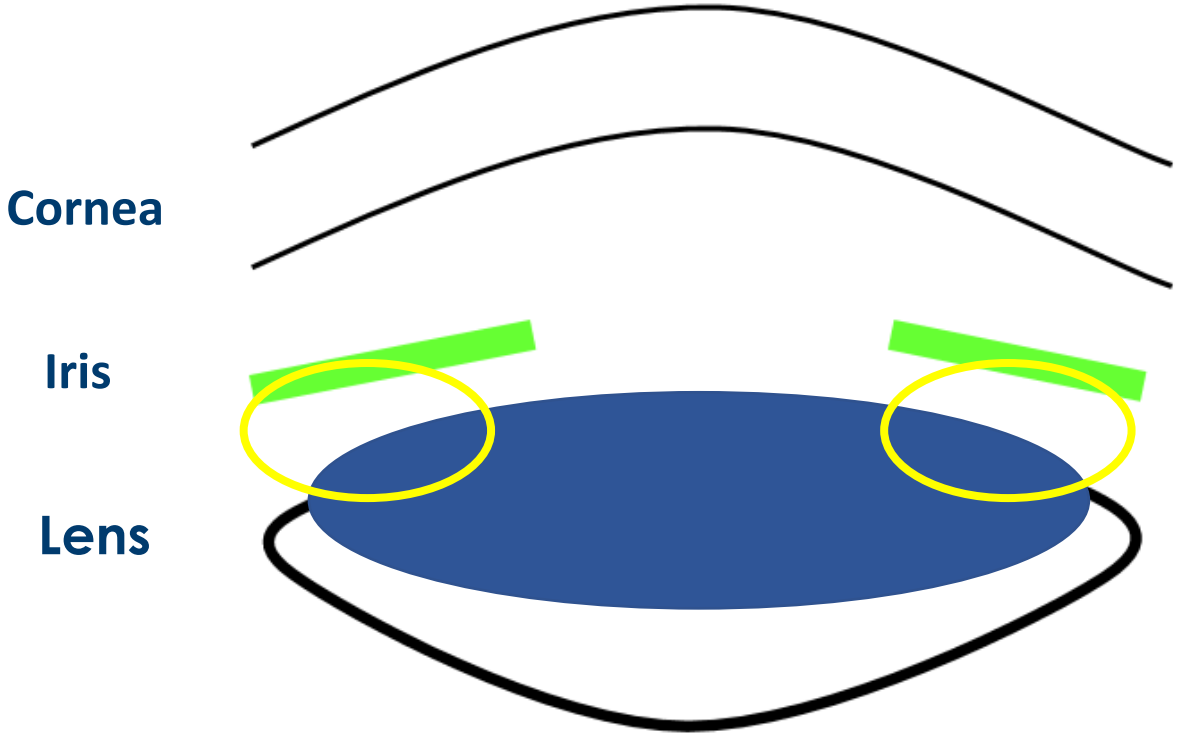
Goal

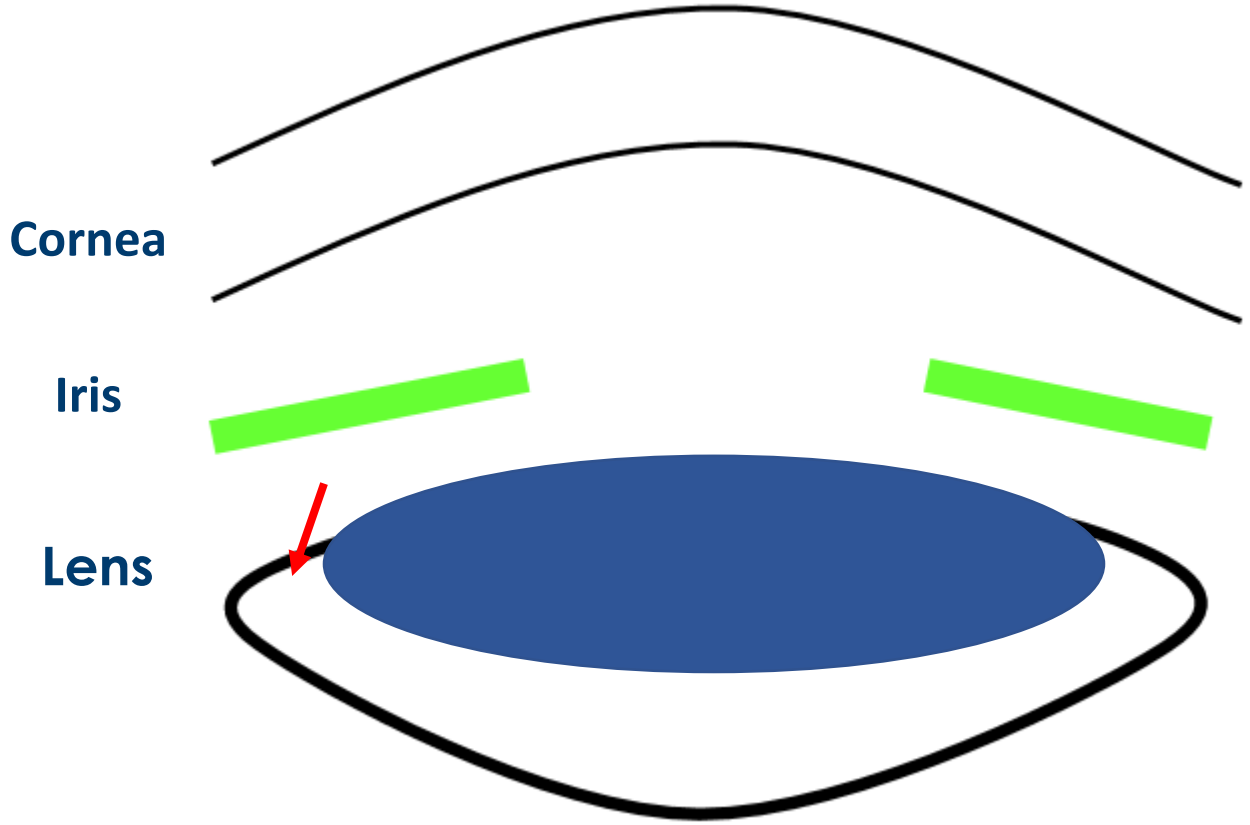
A. IOL centered

B. Capsulotomy Centered
360° overlap of anterior capsule over the optic



Prevent/Minimize
PCO Induced
IOL tilt and Decentration


Cornea
Iris
Lens


Cornea
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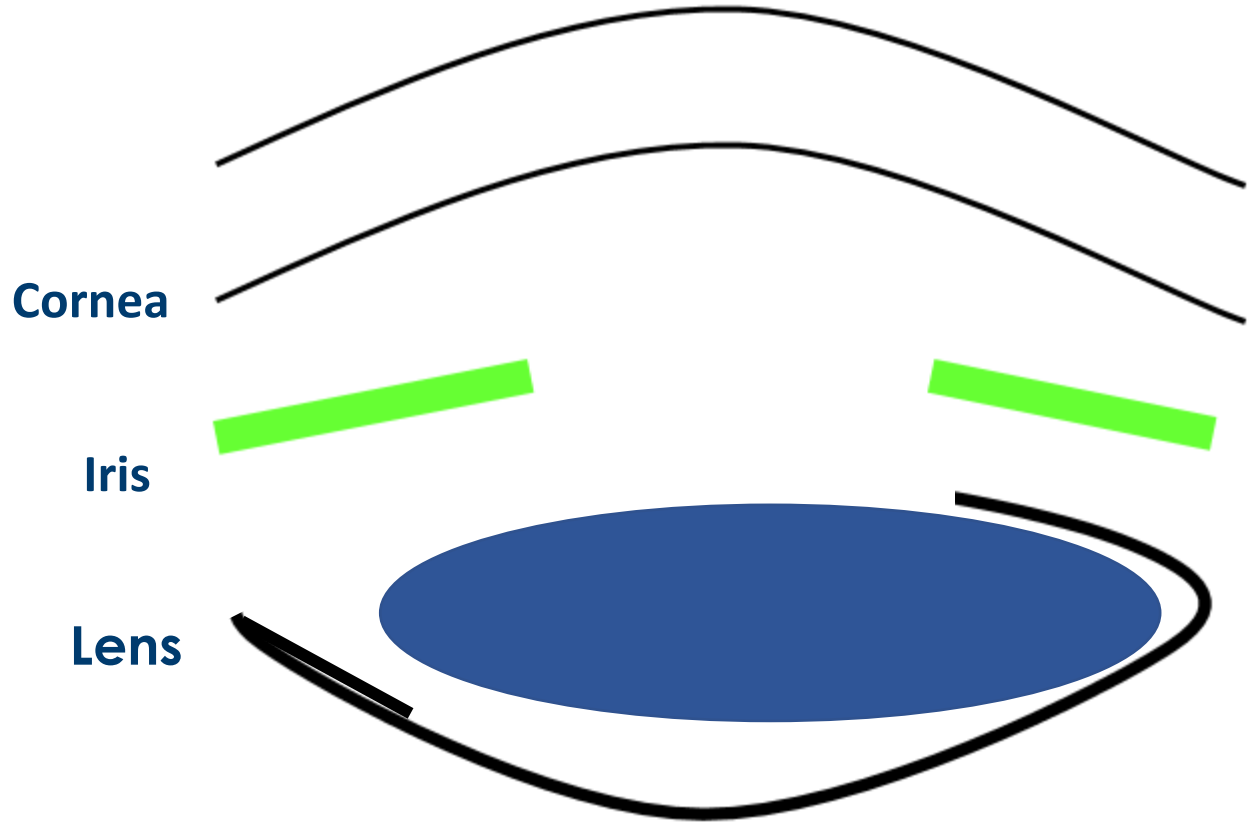
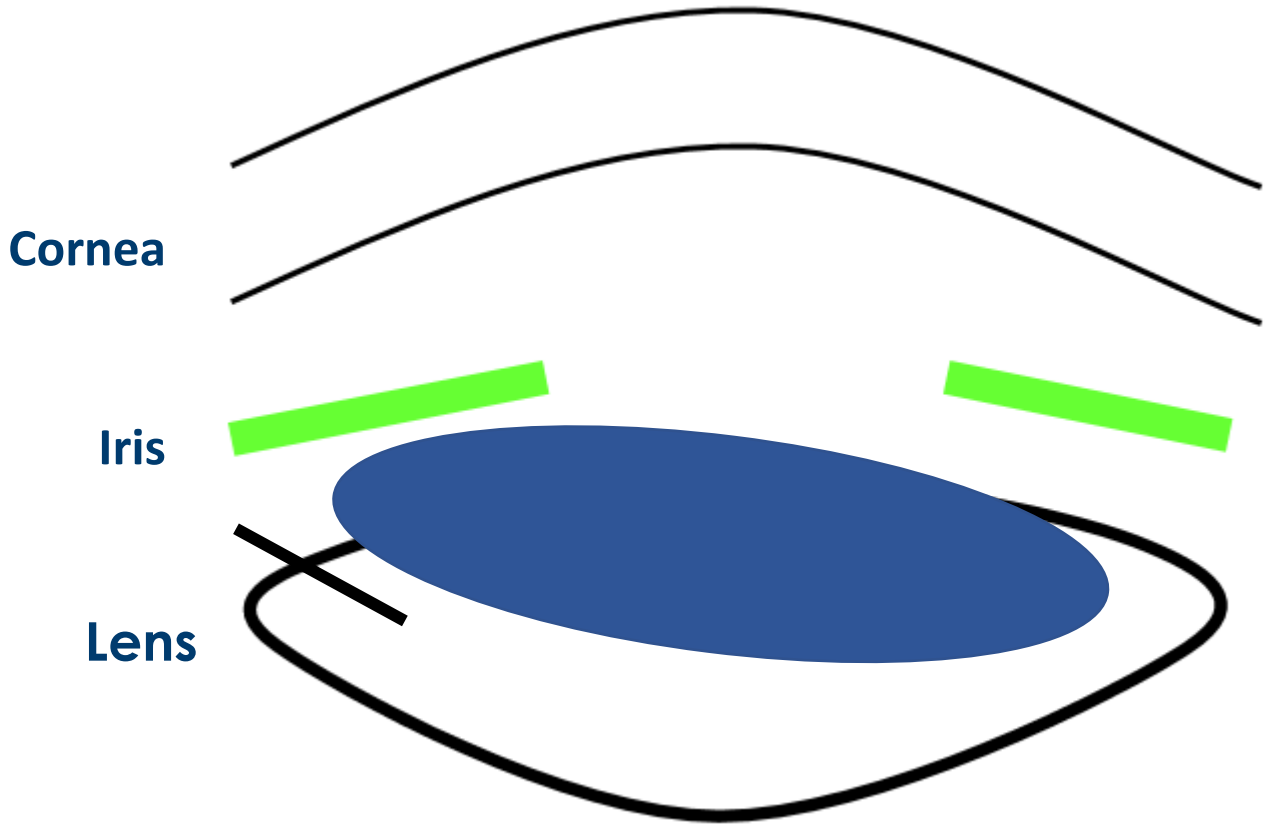
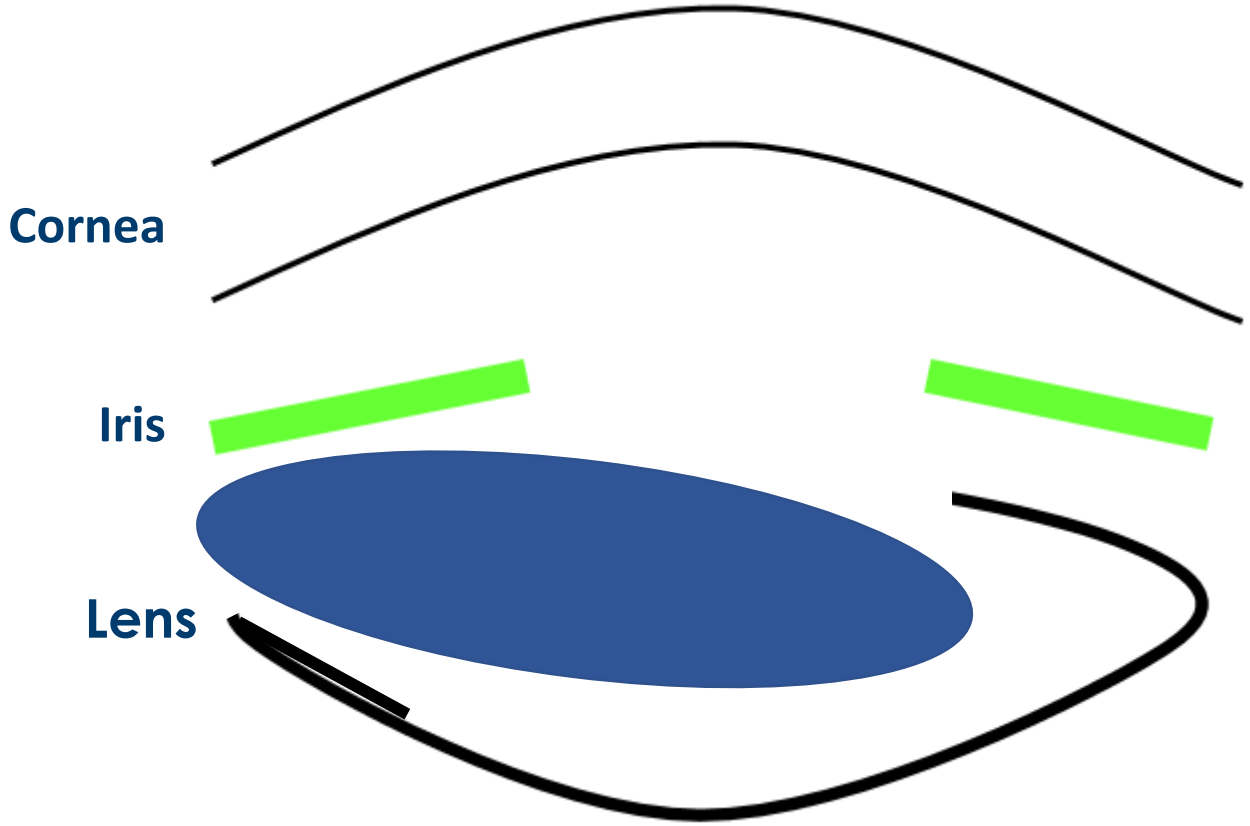
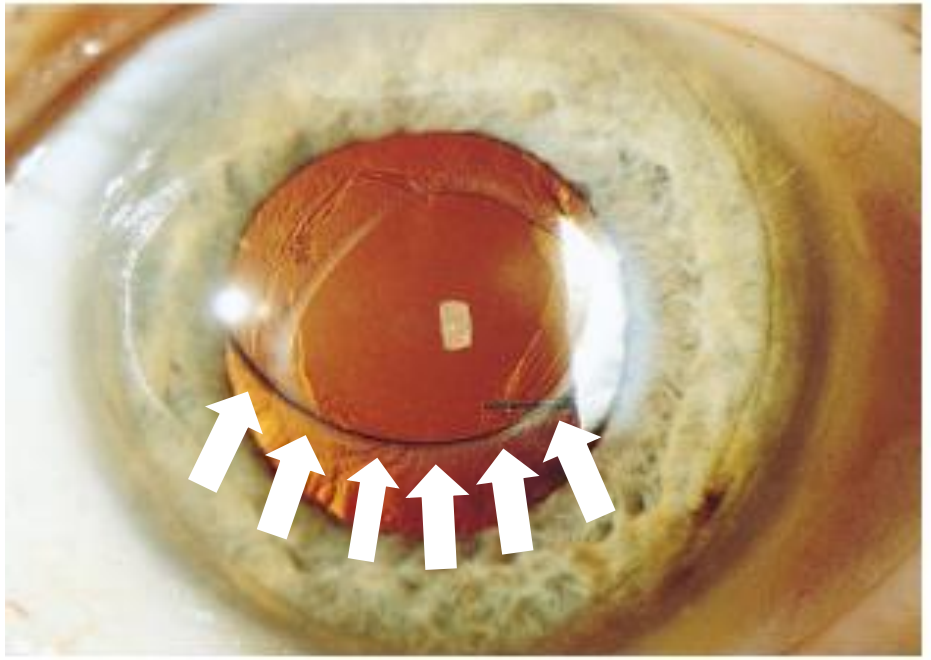

Cornea
Iris
Lens


Cornea
Iris
Lens


Cornea
Iris
Lens



Incomplete capsule overlap of the optic: allow capsular fusion peripheral to the optic with **progressive** adherence. **This fusion can produce IOL decentration** from the edge of the capsulorhexis.

Carlson et al: Surv Ophthalmol 42 (5) March–April 1998

SPECIALTY EYE INSTITUTE

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To Femto or Not to Femto

Paul H. Ernest, M.D.

Co-Authors: Ike Ahmed, M.D.; Parko Popovich; Lindsay Klumpp, O.D.

Study Findings Internal Coma - Outliers

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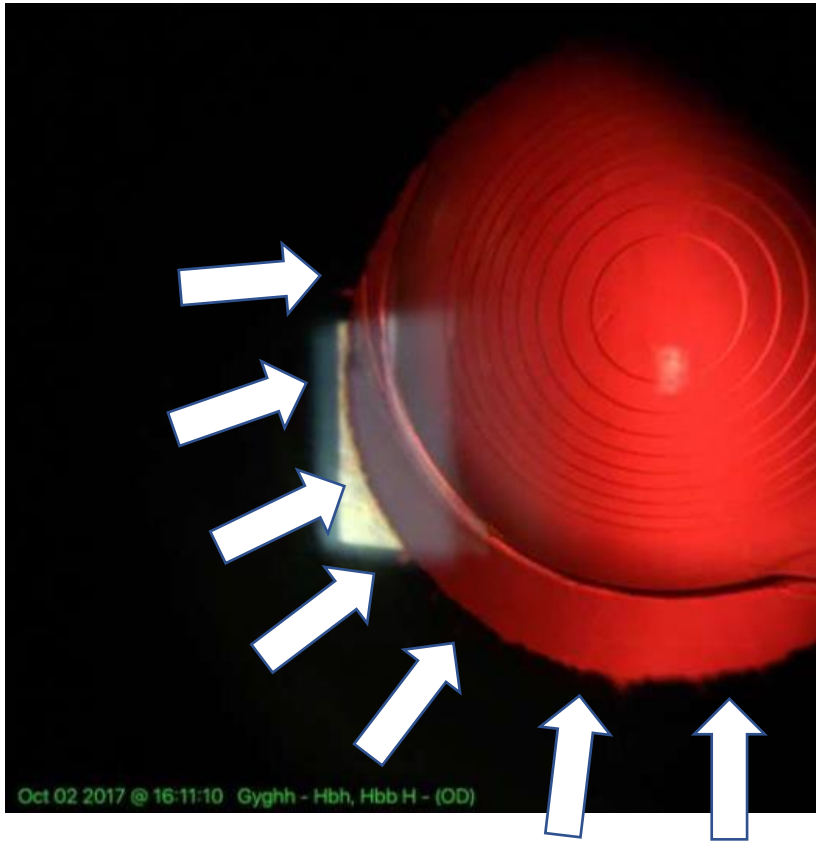
- **2.05 microns of internal coma**
- **4 clock hours of asymmetrical overlap of anterior capsule on the optic surface**



Summary

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- There is a direct correlation between the overlap of the anterior capsule on the optic and higher order aberrations (internal coma)
- The more symmetrical the overlap of the anterior capsule on the optic, the lower the internal coma
- The Femtosecond laser gives a more symmetrical overlap of the anterior capsule on the optic ($p<0.05$)
- Internal coma affects the quality of the patients' vision under mesopic conditions especially with multifocal lenses (satisfaction survey)

Studies showing IOL centration

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PERSPECTIVE

The Subject-Fixated Coaxially Sighted Corneal Light Reflex: A Clinical Marker for Centration of Refractive Treatments and Devices

DANIEL H. CHANG AND GEORGE O. WARING IV

• PURPOSE: To describe the inconsistencies in definition, application, and usage of the ocular reference axes (optical axis, visual axis, line of sight, pupillary axis, and topographic axis) and angles (angle kappa, lambda, and alpha) and to propose a precise, reproducible, clinically defined reference marker and axis for centration of refractive treatments and devices.
• DESIGN: Perspective.
• METHODS: Literature review of papers dealing with ocular reference axes, angles, and centration.
• RESULTS: The inconsistent definitions and usage of the current ocular axes, as derived from eye models, limit their clinical utility. With a clear understanding of Purkinje images and a defined alignment of the observer, light source/fixation target, and subject eye, the subject-fixated coaxially sighted corneal light reflex can be a clinically useful reference marker. The axis formed by connecting the subject-fixated coaxially sighted corneal light reflex and the fixation point, the subject-fixated coaxially sighted corneal light reflex axis, is independent of pupillary dilation and phakic status of the eye. The relationship of the subject-fixated coaxially sighted corneal light reflex axis to a refined definition of the visual axis without reference to nodal points, the foveal-fixation axis, is discussed. The displacement between the subject-fixated coaxially sighted corneal light reflex and pupil center is described not by an angle, but by a chord, here termed chord mu. The application of the subject-fixated coaxially sighted corneal light reflex to the surgical centration of refractive treatments and devices is discussed.
• CONCLUSION: As a clinically defined reference marker, the subject-fixated coaxially sighted corneal light reflex avoids the shortcomings of current ocular axes for clinical application and may contribute to better consensus in the literature and improved patient outcomes. (Am J Ophthalmol 2014;158:863–874. © 2014 by Elsevier Inc. All rights reserved.)

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From Empire Eye and Laser Center, Bakersfield, California (D.H.C.); Medical University of South Carolina, Storm Eye Institute, Charleston, South Carolina (G.O.W.); and Department of Bioengineering and Science, Clemson University, Clemson, South Carolina (G.O.W.).
Inquiries to Daniel H. Chang, Empire Eye and Laser Center, 4101 Empire Dr, Ste 120, Bakersfield, CA 93309; e-mail: dchang@empireeyeandlaser.com

CENTRATION OF INTRAOCULAR LENSES (IOLS) AND refractive corneal treatments has always been important; but with the development of wavefront and topography-guided treatments, aspheric and multifocal IOLs, and corneal inlays, there has been a renewed interest in the matter. Any attempt at centration implies the identity of a reference center point. Without the proper frame of reference, descriptions of centration have limited reproducibility, utility, and relevance. This article examines the ocular axes and angles as described in the literature and suggests an alternative to applying the theoretical reference axes in the clinical setting. Reference markers that can be identified clinically are described, and a new clinically defined reference axis for preoperative measurement, intraoperative alignment, and postoperative assessment of refractive treatments and devices is presented.

THE REFERENCE AXES AND THEIR LIMITATIONS

THE HUMAN EYE IS NOT A CENTERED OPTICAL SYSTEM, AS the fovea does not lie along the optical axis of the eye.[1] The lens and cornea are slightly tilted and decentered relative to each other.[2] These multiple unaligned refractive surfaces create challenges in both the optical description of the eye and the clinical determination of centration. In an attempt to study the optical properties of the eye, vision researches have created simplified models and described ocular reference axes to characterize these models.[1,3–6] These axes have proven useful in modeling the eye and describing ocular alignment and motility issues.[5] However, they lack the specificity and precision to be clinically useful in refractive corneal and intraocular surgery.

A review of the literature reveals that a number of ocular axes have been used to relate the optical structures of the eye, namely the optical axis, visual axis, line of sight, and

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http://dx.doi.org/10.1016/j.ajo.2014.06.028

Internal coma

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Associated with IOL tilt and decentration increases with pupil size

Mihá ltz K, Knorz MC, Alió JL, Takács AI, Kránitz K, Kovács I, Nagy ZZ. Internal aberrations and optical quality after femtosecond laser anterior capsulotomy in cataract surgery. J Refract Surg. 2011 Oct;27(10):711-6.

Performing a precise anterior capsulorrhexis is crucial in cataract surgery. A capsulorrhexis with a 360° overlapping capsular edge prevents optic decentration, tilt, myopic shift, posterior and anterior capsular opacification due to symmetric contractile forces of the capsular bag, and shrink wrap effect.[1-6] In earlier reports from our re-

TECHNIQUE

Streamlined method for anchoring cataract surgery and intraocular lens centration on the patient's visual axis

Vance Thompson, MD

I describe an intraoperative method for the consistent anchoring of the intraocular lens (IOL) and cataract surgery and on the patient's visual axis using coaxial microscope optics, surgeon-guided patient fixation, the precision pulse capsulotomy (PPC) device (Zepto) and utilizing the first (and fourth) Purkinje images. During surgery using a microscope with coaxial lights and optics, the patient is instructed to fixate on a given microscope light while the surgeon looks through the corresponding coaxial eyepiece. Then, the PPC device is centered on the Purkinje I image and a capsulotomy is performed. The resulting capsulotomy serves as a reference marker for the visual axis and IOL placement, with even capsule overlap, which results in IOL centration on this axis landmark. This method might help address the high variability in angle κ from patient to patient and provide visual benefits in cases of implantation of multifocal IOLs and other IOLs.

J Cataract Refract Surg 2018; 44:528–533 © 2018 Published by Elsevier Inc. on behalf of ASCRS and ESCRS

Online Video

Surgeons vary in their approach to capsulotomy and intraocular lens (IOL) centration during cataract surgery. Some do not consider the anatomic or functional axes of the eye and do not routinely practice centration. Others commonly use the center of the dilated pupil because if its convenience as an easily visible landmark. In these cases, a manual continuous curvilinear capsulorhexis (CCC) is created to approximate a circular capsule opening centered on the pupillary center and the IOL is positioned to achieve capsule overlap as evenly as possible. Imprecision comes about as a result of the inherent deviation from roundness and centration of a capsulotomy created by hand and the potential asymmetry of the dilated pupil. In addition, the pupillary axis is displaced with respect to the visual axis by angle κ,[1,2] which is highly variable in pseudophakic patients.[3] This high degree of variability in angle κ between patients translates into a high degree of variability in chord mu,[2] which closely approximates the distance between the location of the visual axis and the pupillary center on the capsule plane. Chord mu variability might contribute to inconsistent or suboptimum outcomes when the pupillary center is used for alignment, in particular in cases using aspheric, toric, and multifocal IOLs.[4–8]

This paper describes an intraoperative method for the consistent anchoring of cataract surgery and IOL centration on the patient's visual axis using coaxial microscope lights and optics, brief patient fixation, and a precision pulse capsulotomy (PPC) device (Zepto, Mynosys Cellular Devices, Inc.)[9–11] to center on the first Purkinje image as it becomes aligned with the fourth Purkinje image. This technique is based on the subject-fixated coaxially sighted corneal light reflex as described by Chang and Waring[2] paired with the use of the PPC device. In this technique, the PPC device serves a dual function. The first is to assist the surgeon in establishing coaxial sighting along the patient's visual axis. The second is the conversion of the patient's individual visual axis into a visual axis–centered capsulotomy that is then used as a reference marker later in surgery. During surgery, with the transparent PPC suction cup inserted into the anterior chamber, the patient is instructed to fixate on a microscope light selected by the surgeon while the surgeon looks through the corresponding coaxial eyepiece. The PPC device is then centered on the Purkinje I (PI) image, which marks the patient's visual axis, and a capsulotomy is performed. The fourth Purkinje image should be aligned and mostly hidden behind

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From Vance Thompson Vision, Sioux Falls, South Dakota, USA.

Supported in part by surgical devices provided by Mynosys Cellular Devices, Inc., Fremont, California, USA.

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0886-3350/$ - see frontmatter
https://doi.org/10.1016/j.jcrs.2018.02.013

Techniques

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- **Femto**
- **Zepto**
- **Manual**

Three ”Cs” of a capsule Rhexis

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- Centration
- Circularity
- Cizing

Femto vs. Zepto vs. Manual?

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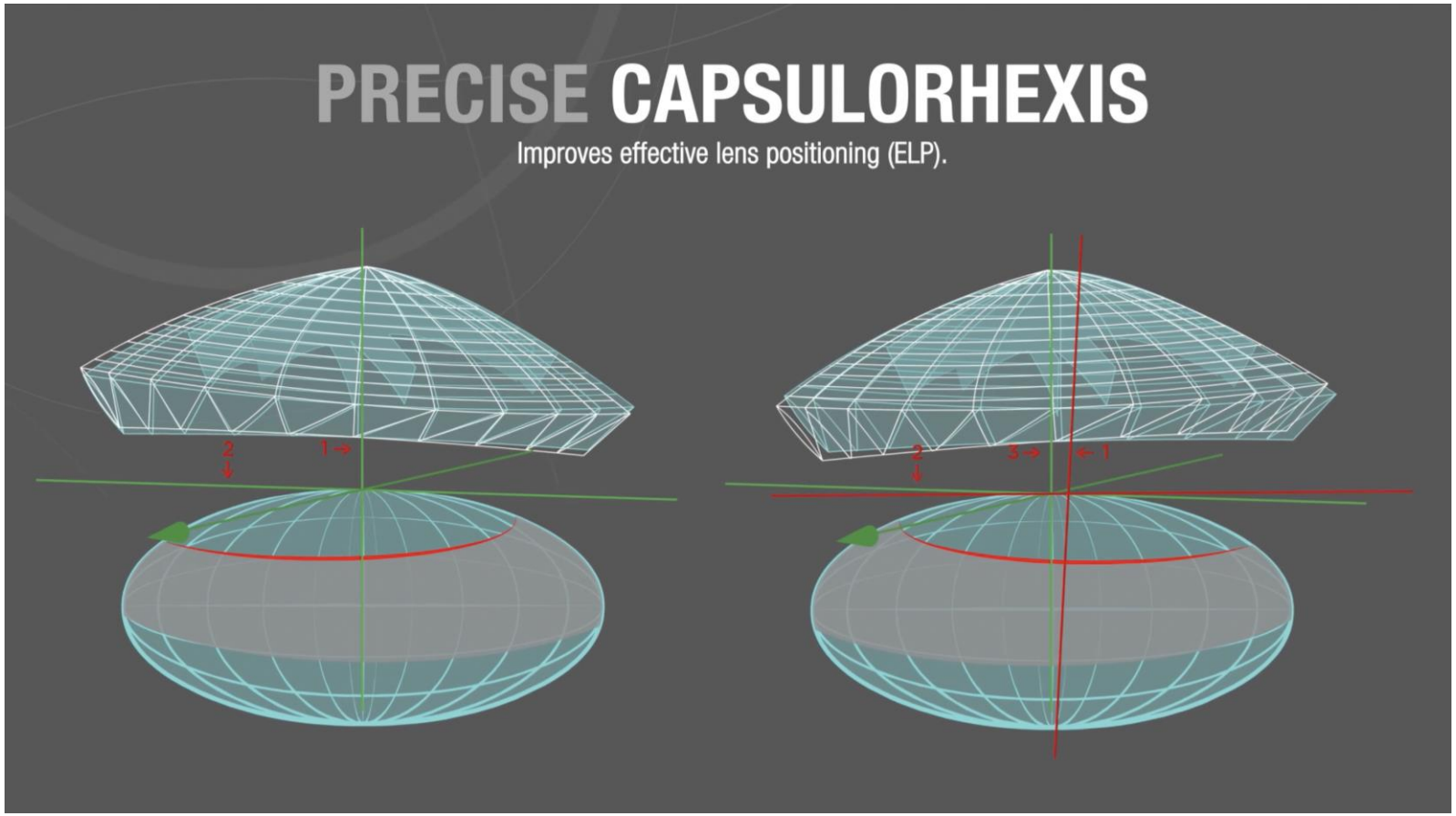

Femto Centration

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- **Lensar**
- **Catalys**
- **Lensx**

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Femtosecond Laser Cataract Surgery

COVER STORY

eyetube.net

Improving Centration With OCT-Guided Laser Capsulotomy

A capsulorrhexis should be an exact circle of a specific size, in a precise position.

BY WILLIAM F. WILEY, MD

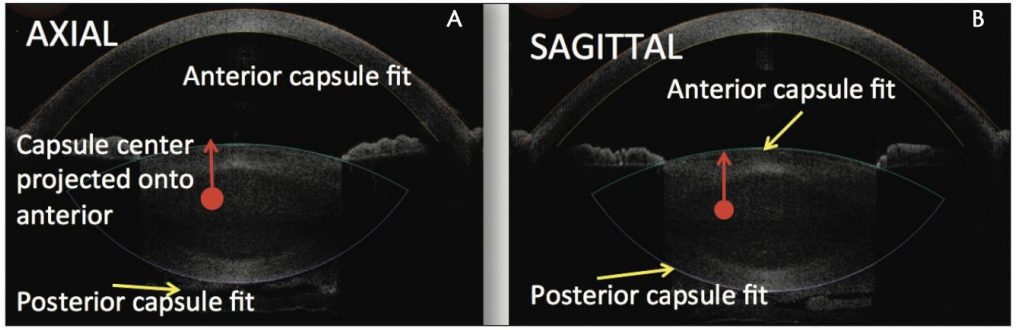
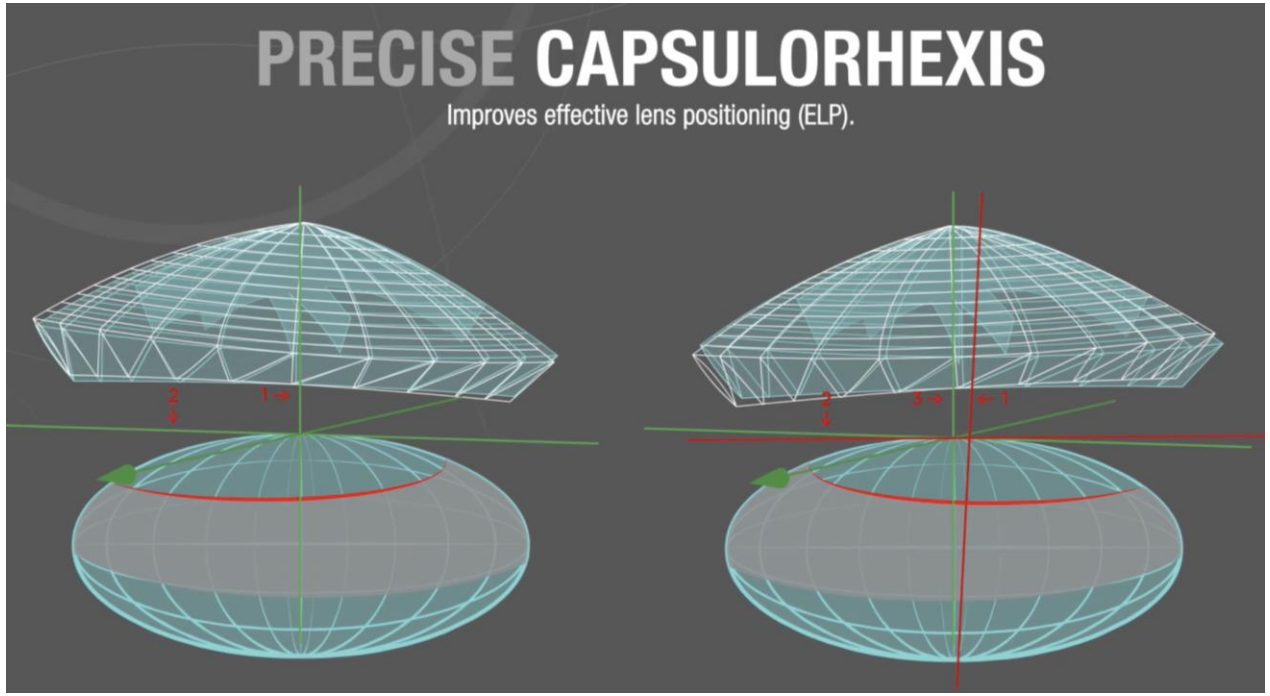
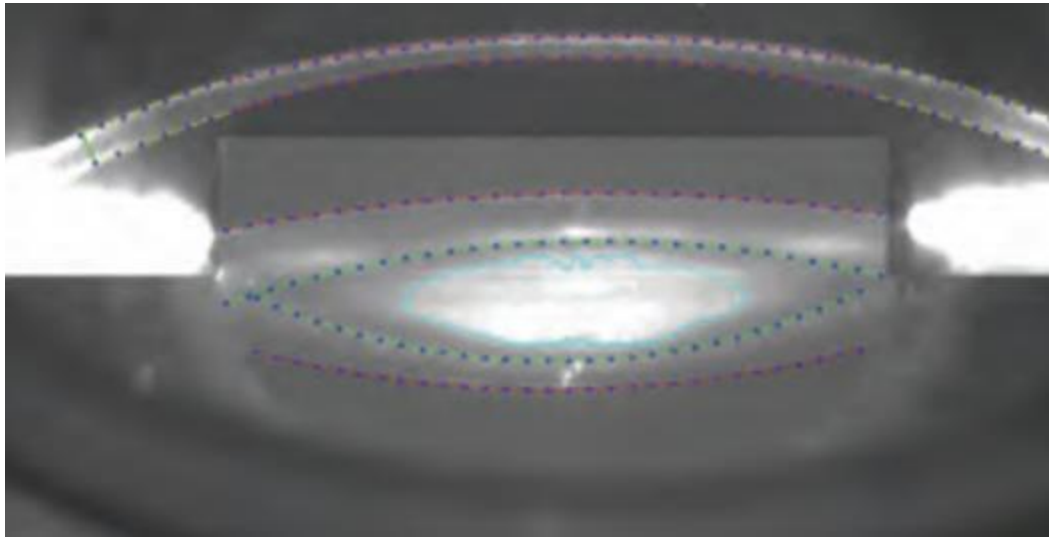


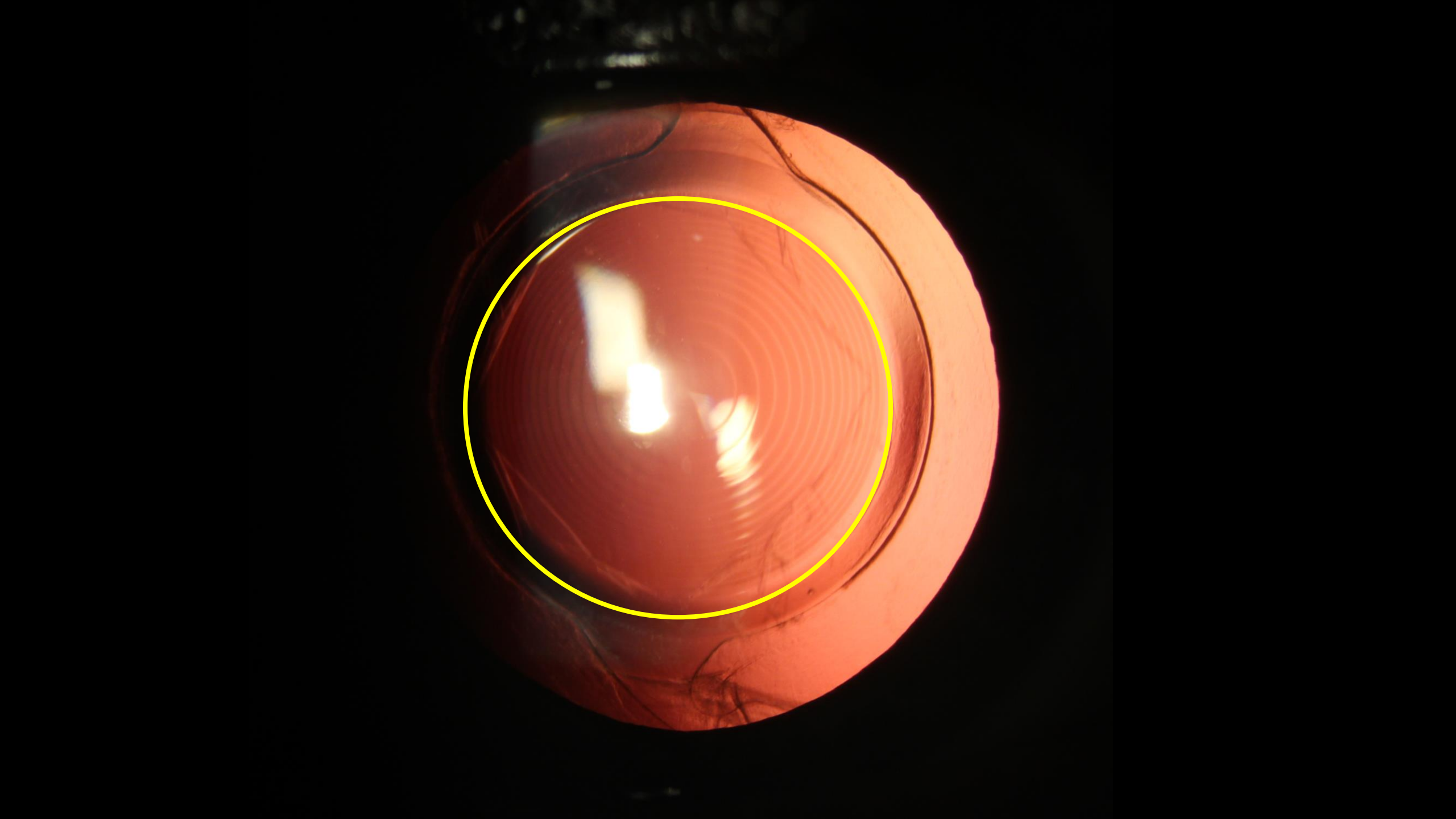
Figure 1. The Catalys laser maps 3-D biometry using high-resolution, high-speed anterior segment OCT imaging of the anterior (turquoise) and posterior (purple) capsules (A and B). Based on these fits, the center of the capsule is identified and then projected onto the anterior capsular surface and can be used to align the center of the IOL.

are less prone to visual aberrations but, when poorly centered, lose their ability to correct astigmatism.

Overall, I find that aspheric optics are somewhat forgiving in regard to the postoperative UCVA. In my experience, I observe more patients with 20/20 vision even when the final refraction is slightly off target. Anecdotally, I have seen patients whose outcomes are 0.50 to 0.75 D off target but are satisfied. This is in contrast to nonaspheric-optic IOLs, which seem to be less forgiving to off-target refractive outcomes.


PRECISE CAPSULORHEXIS
Improves effective lens positioning (ELP).

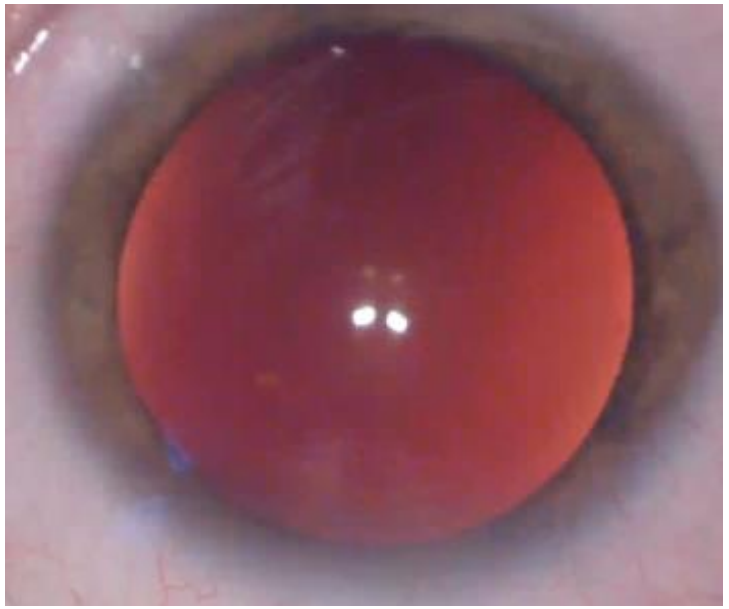




Zepto

Specular reflection

Specular reflection, also known as regular **reflection**, is the mirror-like **reflection** of waves, such as light, from a surface.



Johann Evangelist Purkinje

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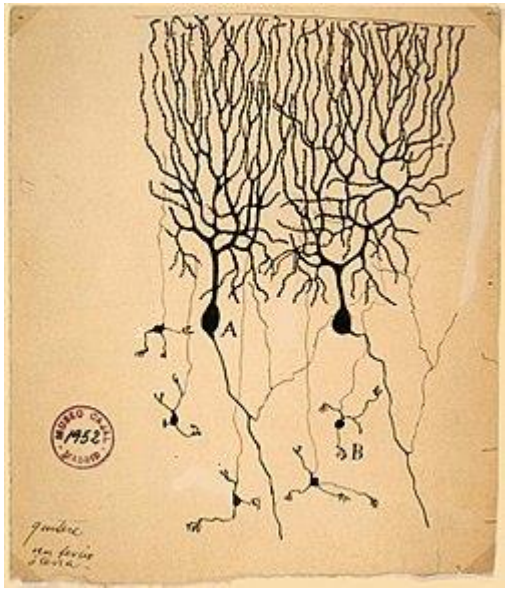
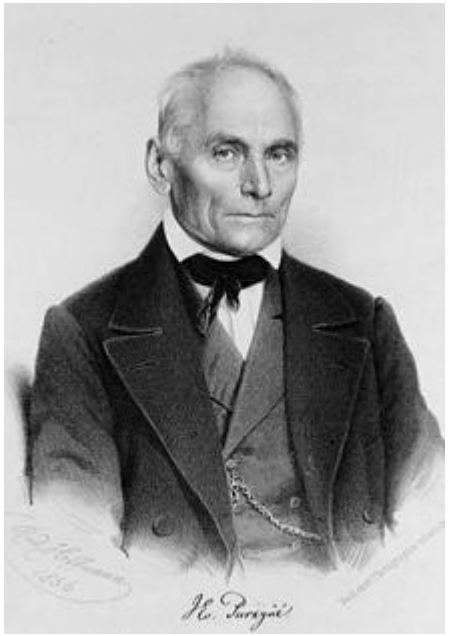
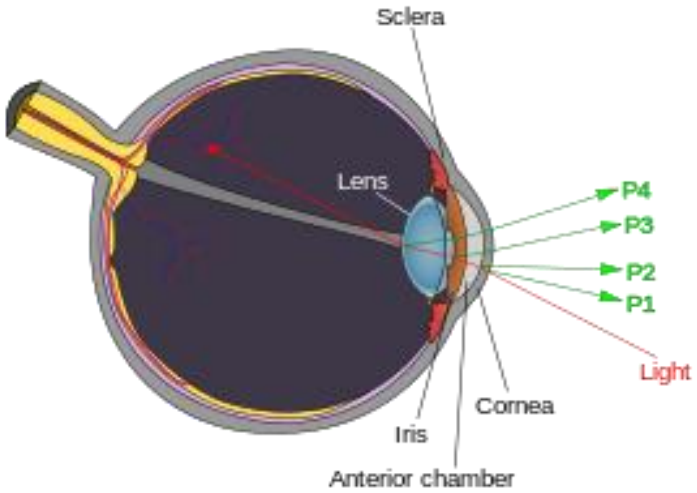
18 December 1787 – 28 July 1869





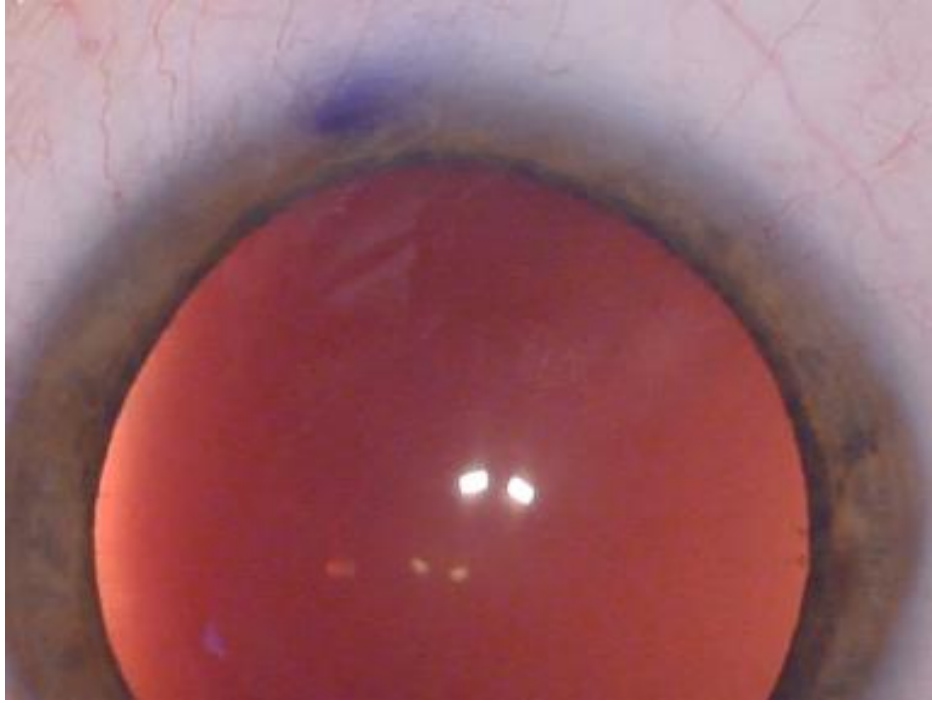
Czech anatomist and physiologist

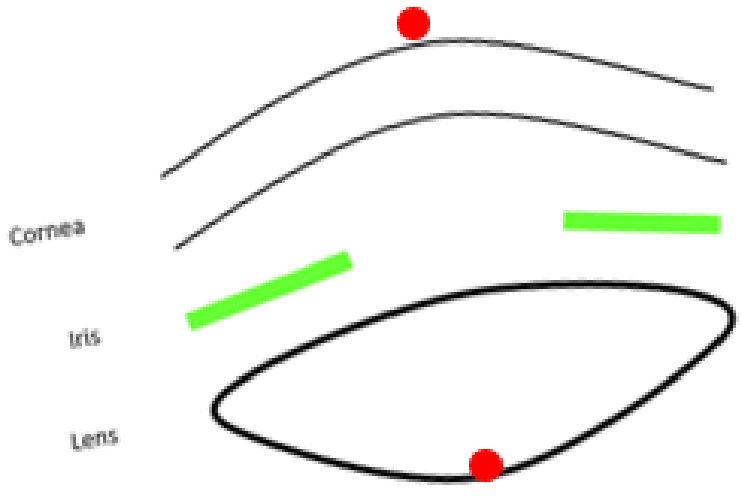


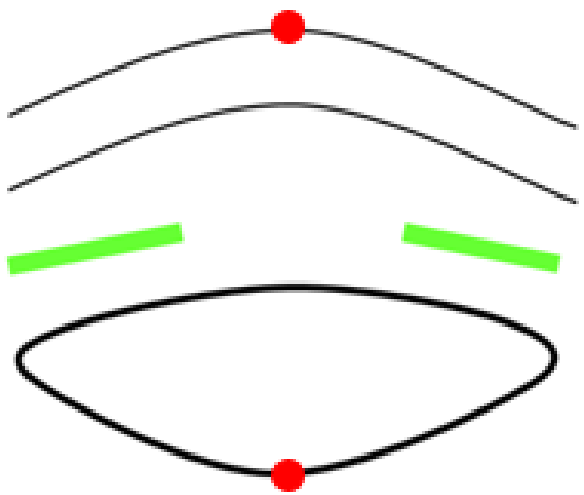
Purkinje Images, Or

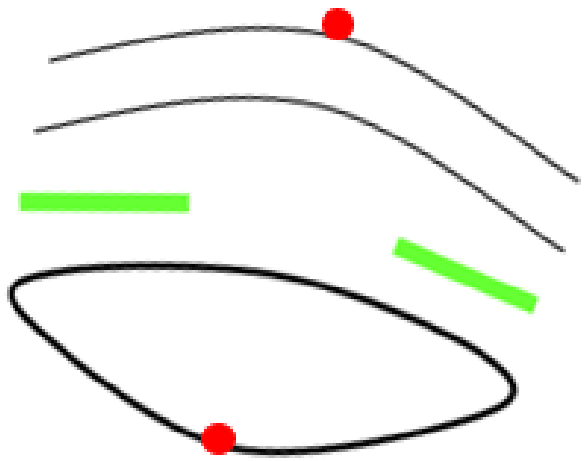
Purkinje-Sanson Images

Louis Joseph Sanson
French surgeon and ophthalmologist




Cornea
Iris
Lens





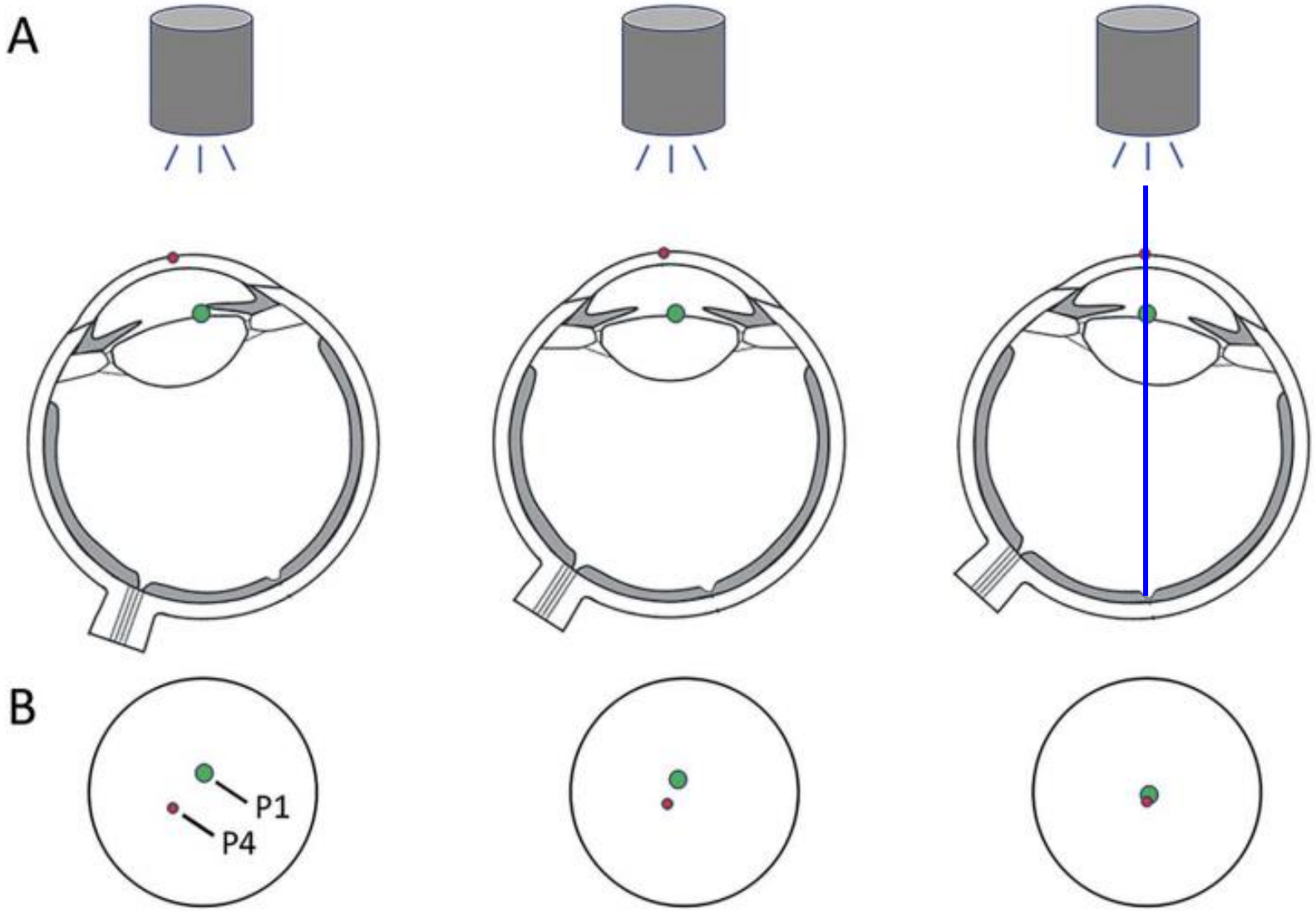
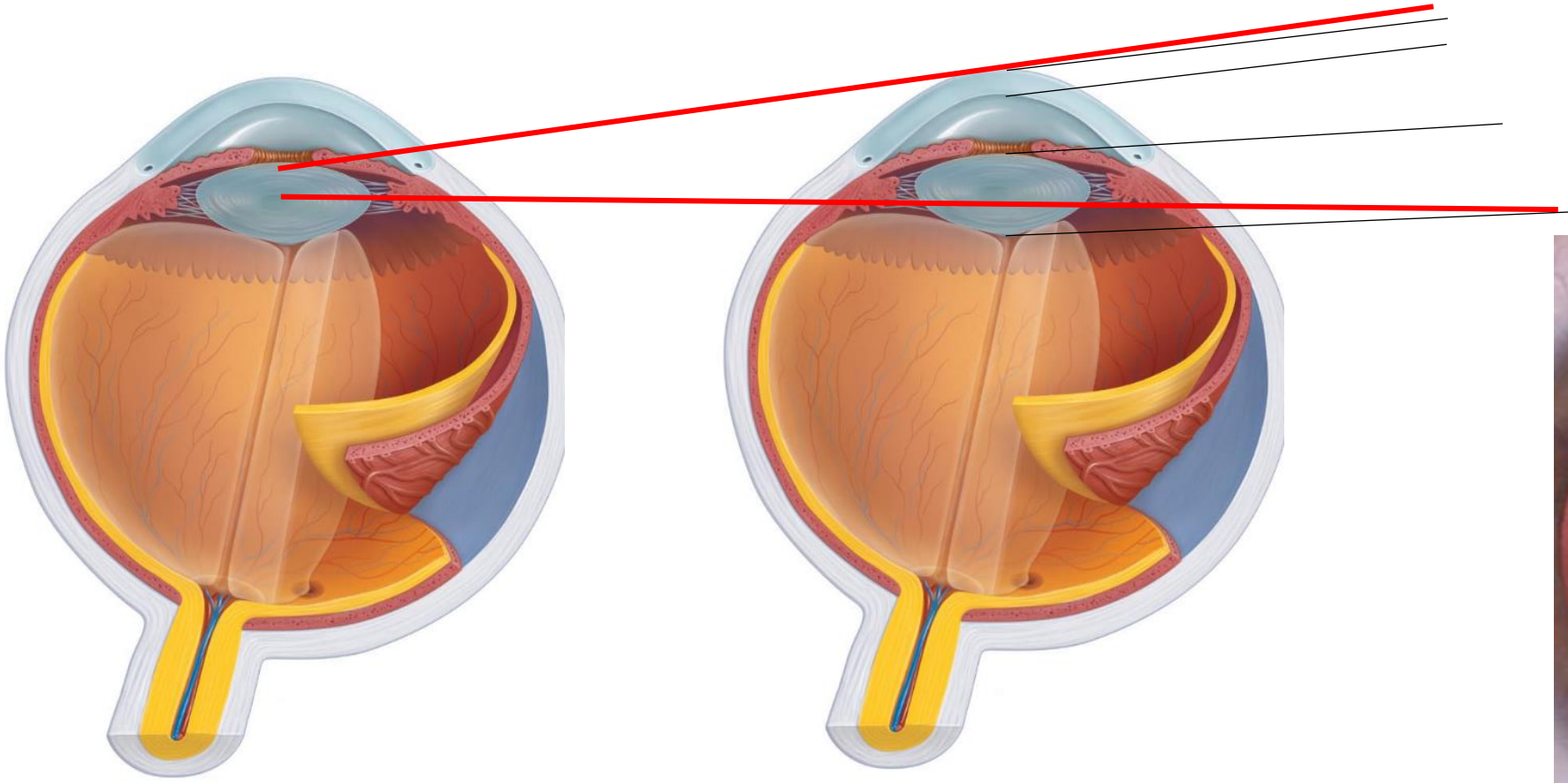
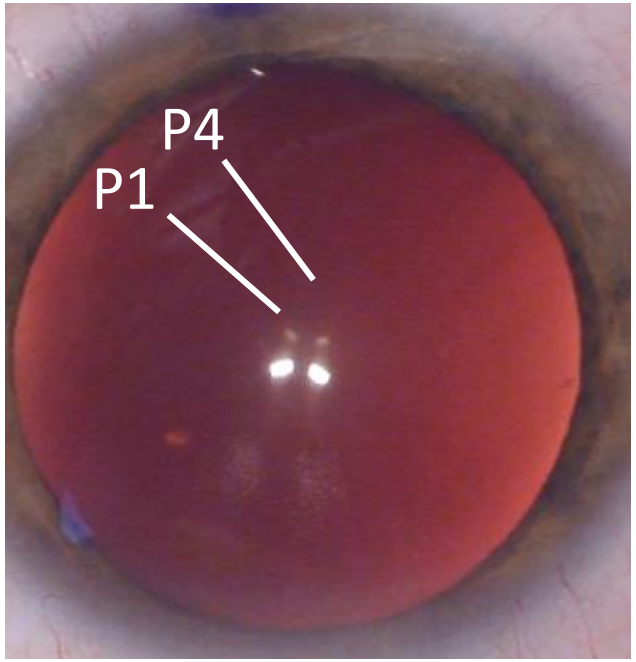
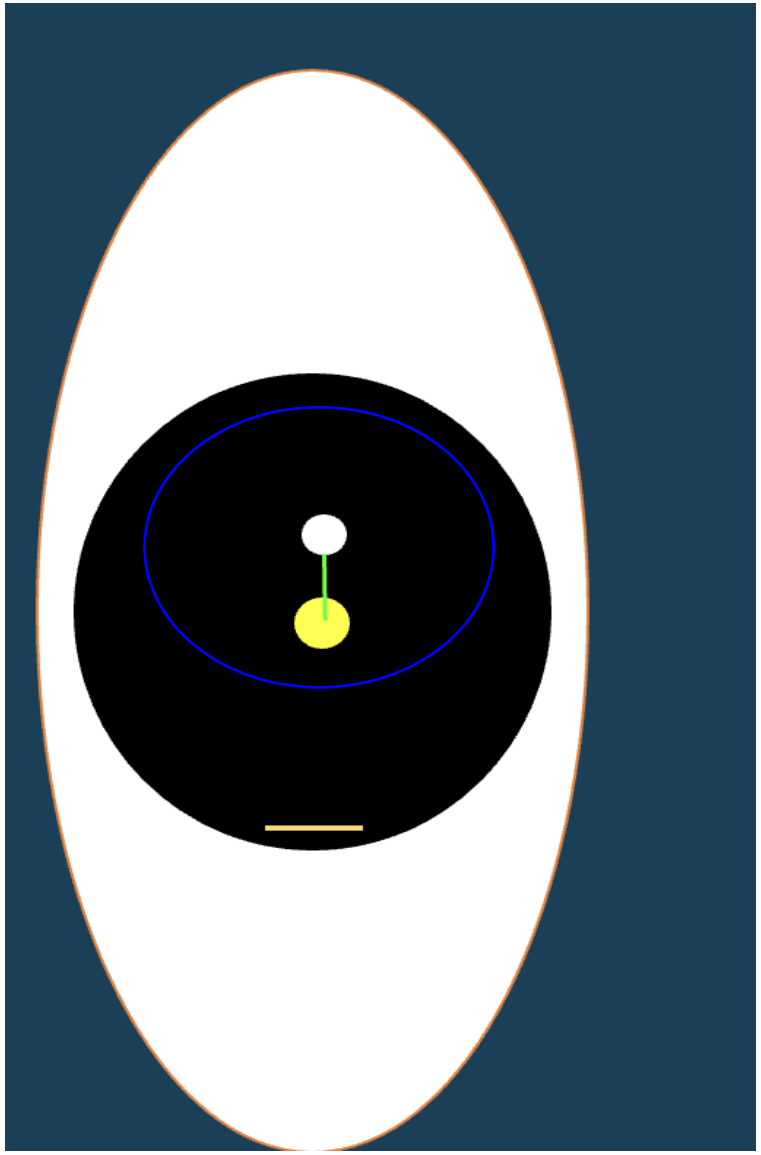


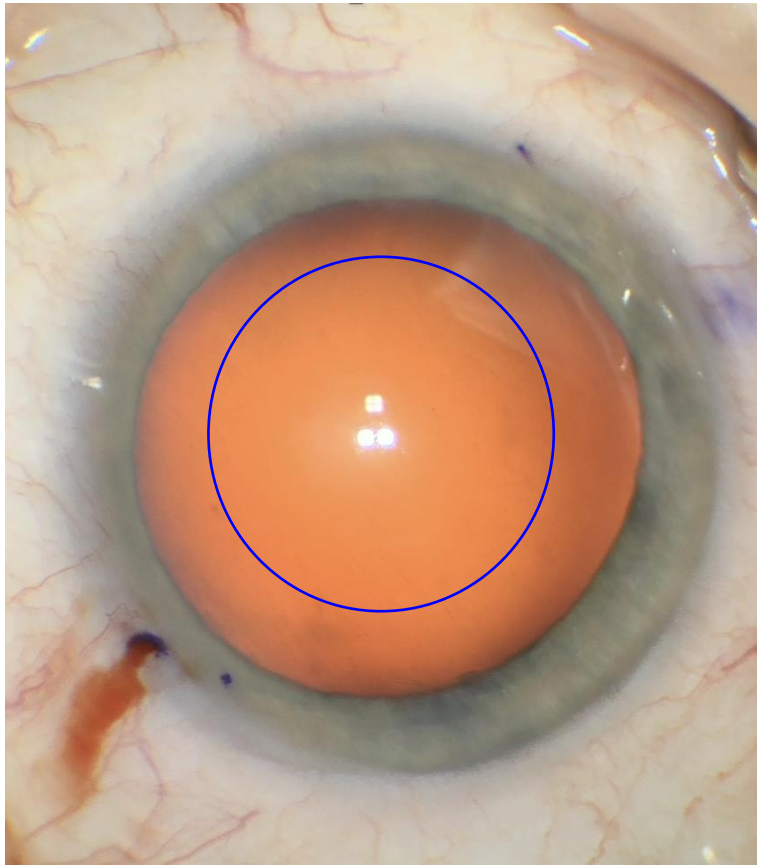
Figure 1. Schematic representation of intraoperative P1/4 relationship on attempted fixation. (*A*) Progressive intraoperative patient fixation on a surgeon-designated light source (from *left to right*). Note that P1 originates on the corneal surface but is actually visualized in the iris-IOL plan, whereas P4 originates at the posterior surface of the lens but is visualized at the corneal plane. Hypothetical locations of P1 on the iris–IOL plane and P4 on the corneal plane are depicted to illustrate the progressive movements of P1 and P4 during patient fixation. (*B*) Schematic diagrams showing the relative positions of P1 (*green dot*) and P4 (*red dot*) as viewed by the surgeon at corresponding positions of patient fixation shown in (*A*). The image on the right illustrates an example P1/4 relationship at fixation.

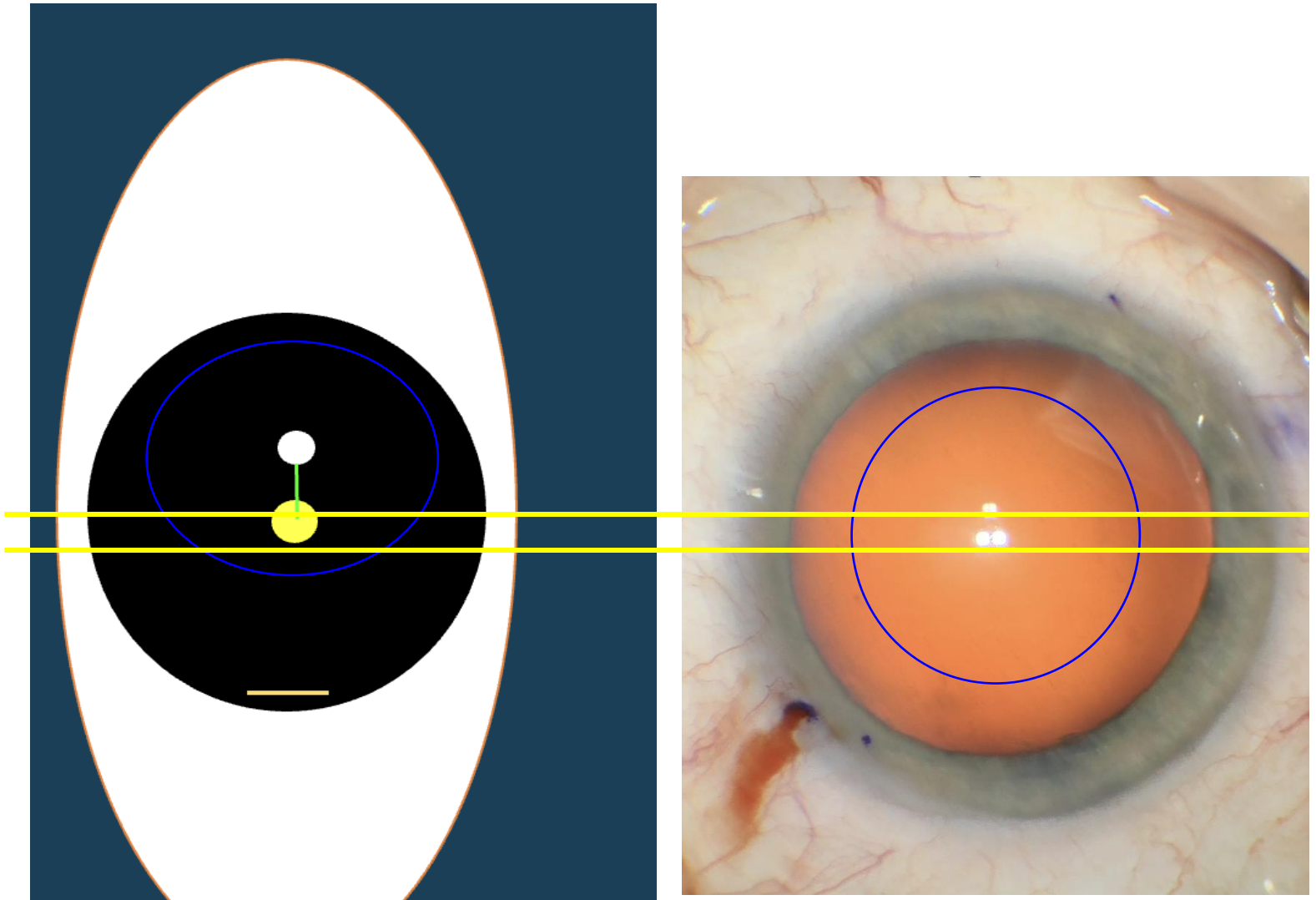
The Purkinje Light Reflexes

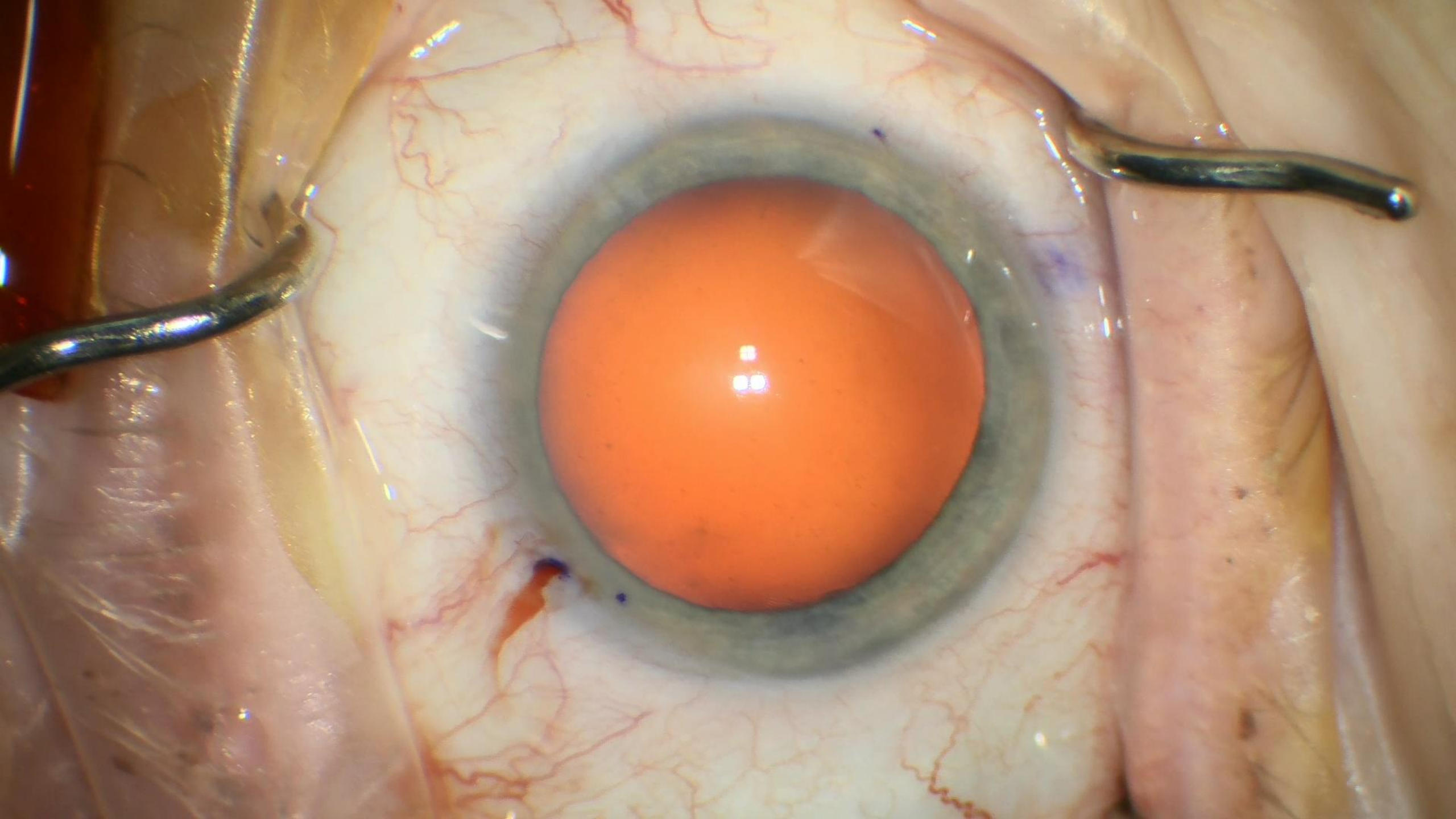


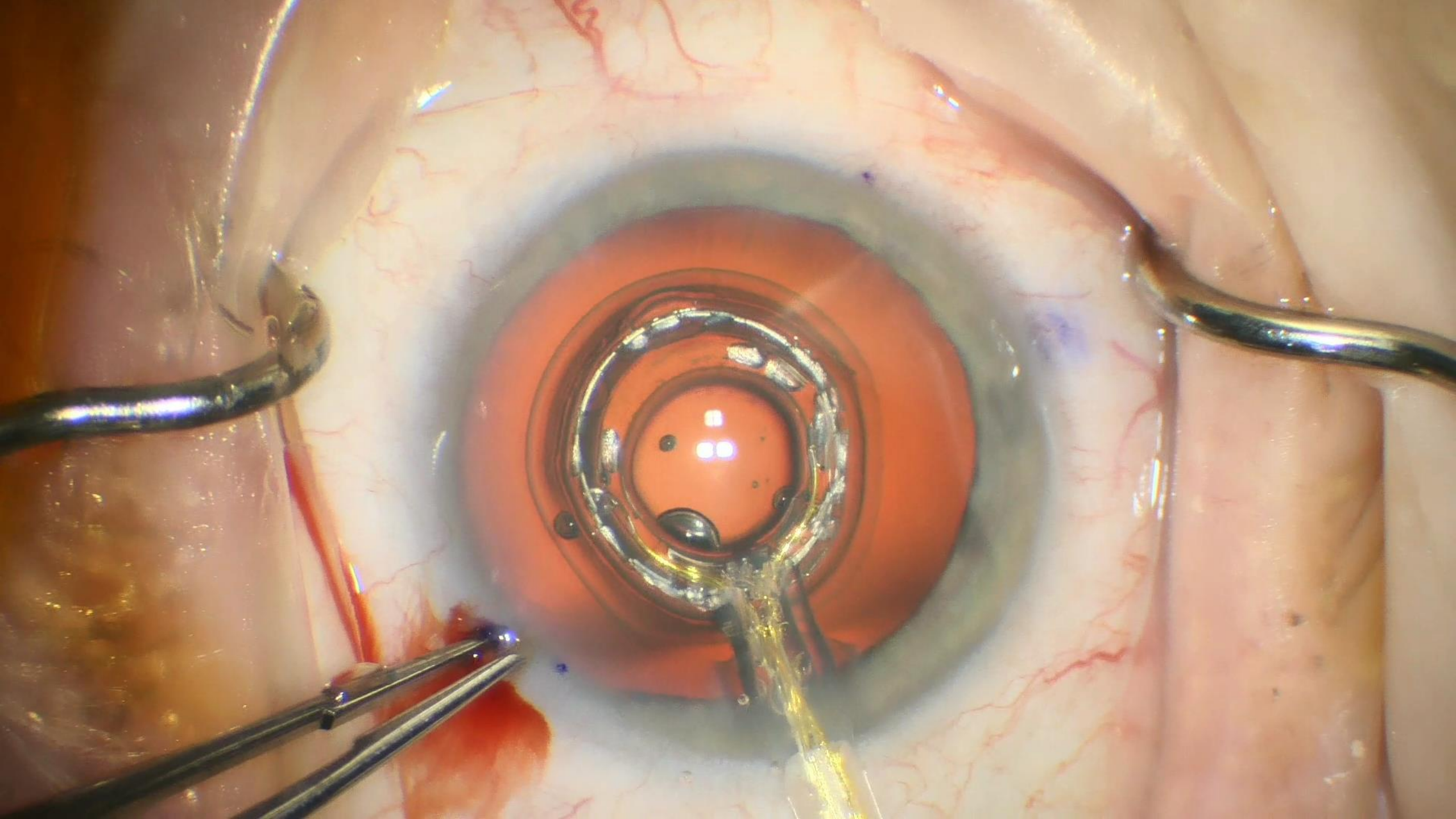


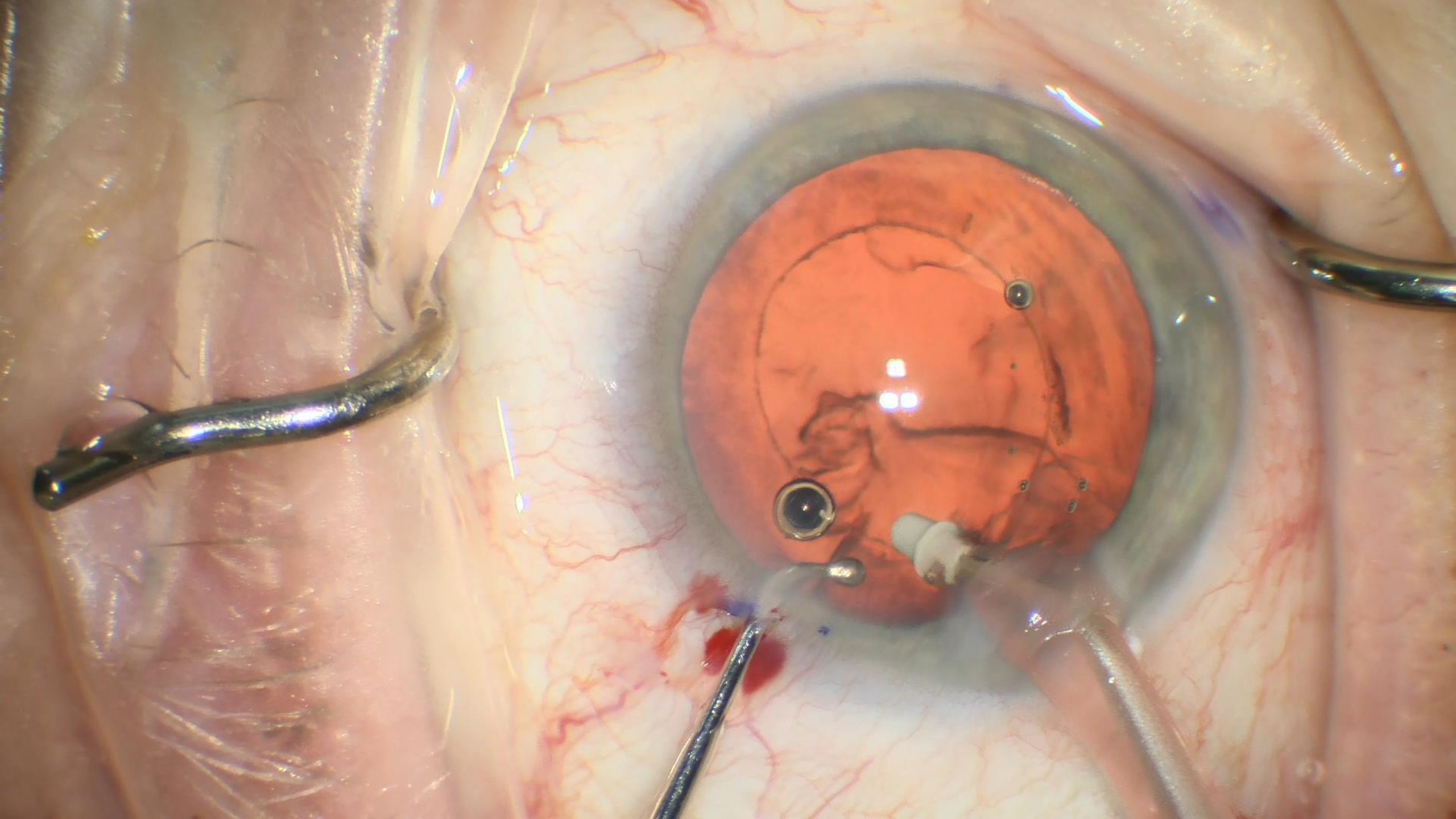


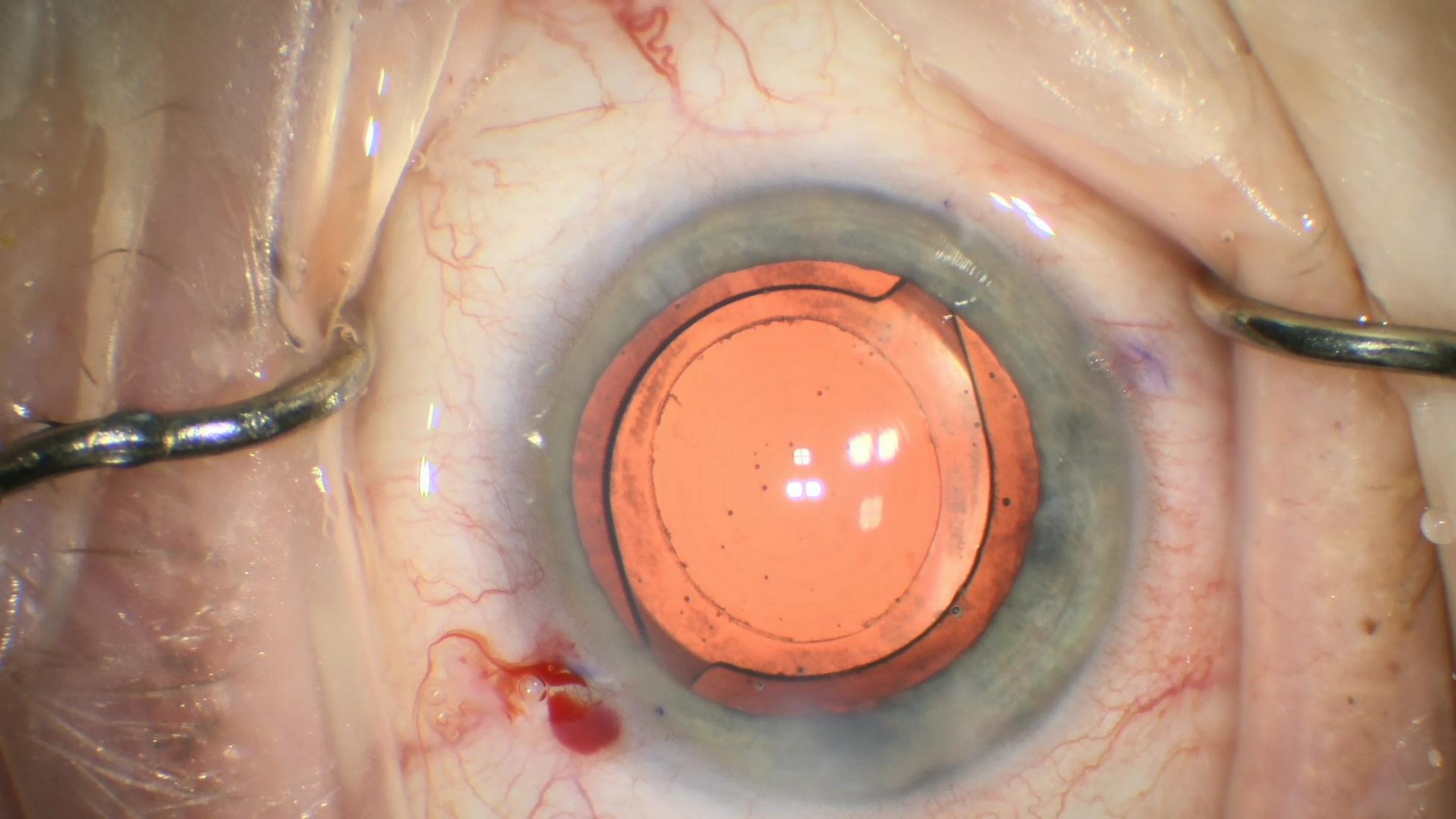




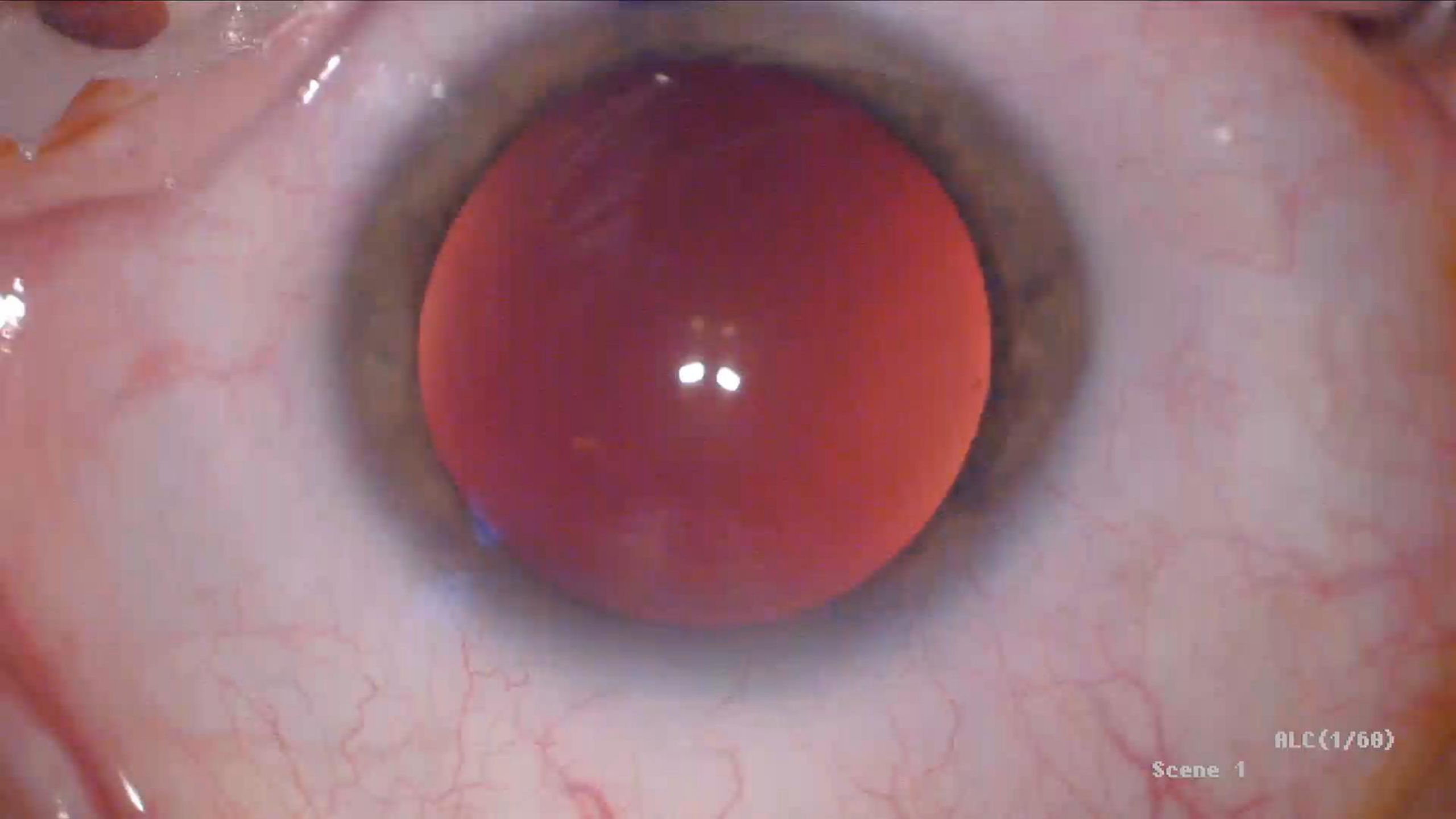


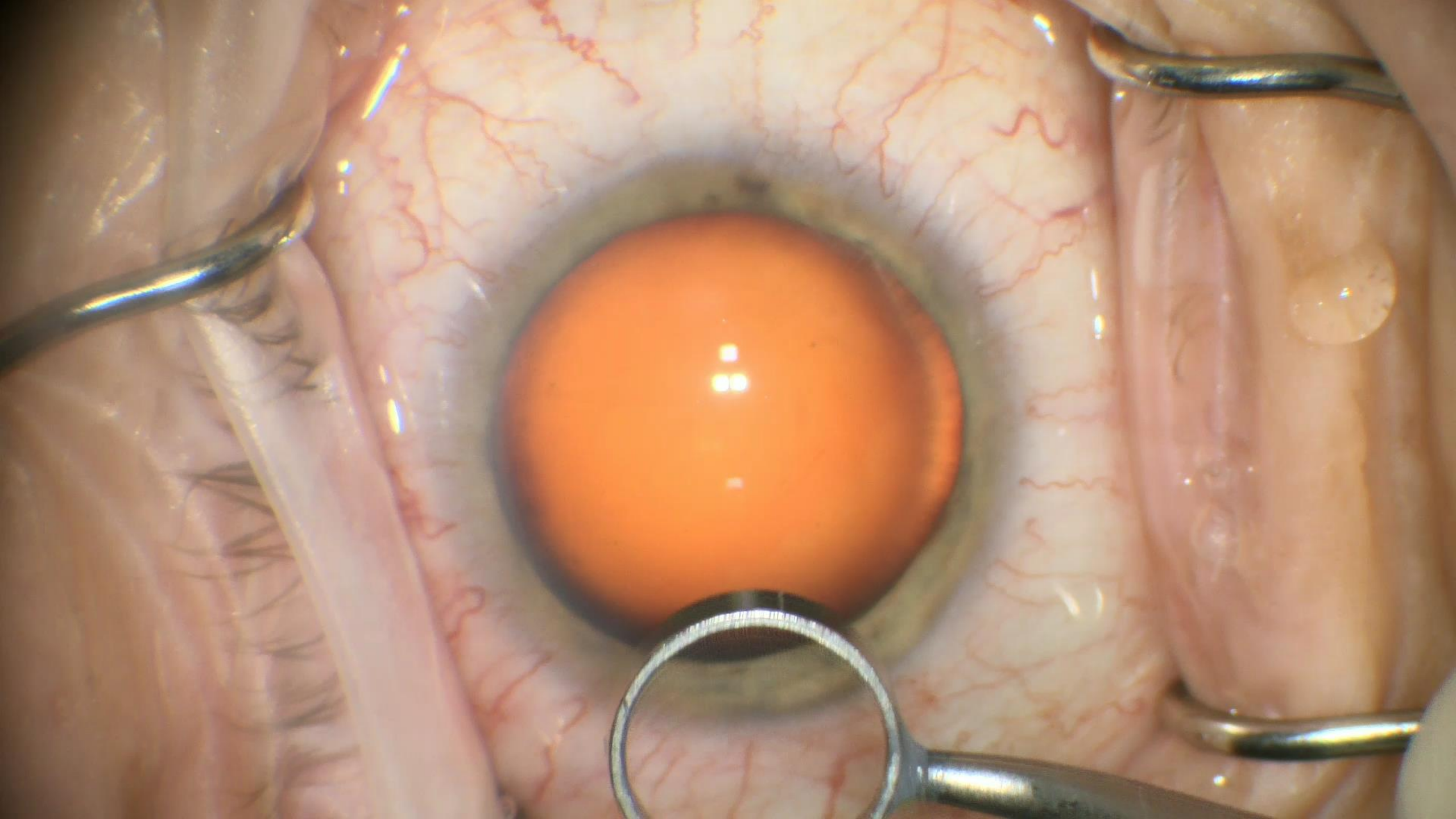






Manual


ALC(1/60)
Scene 1



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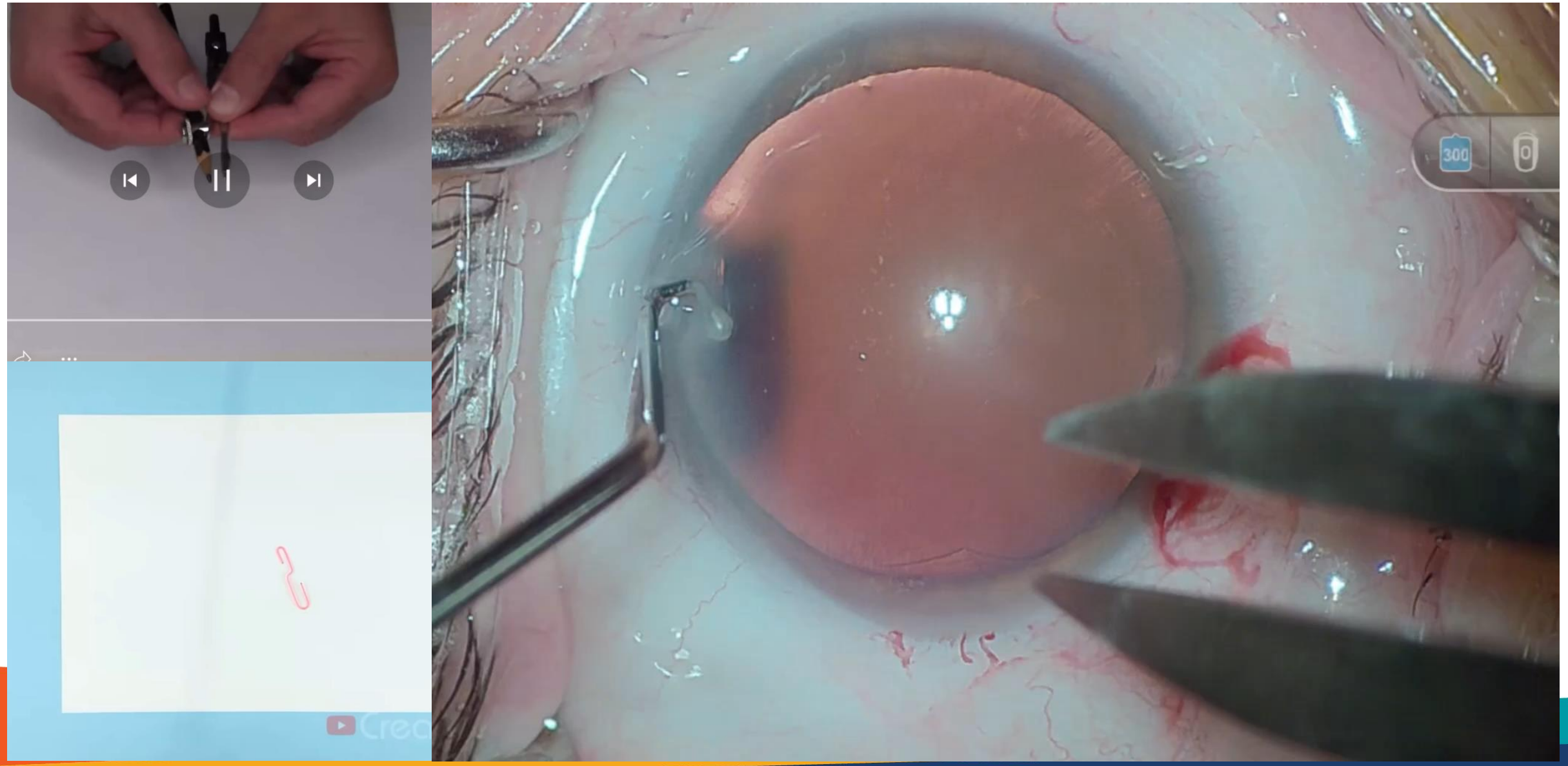
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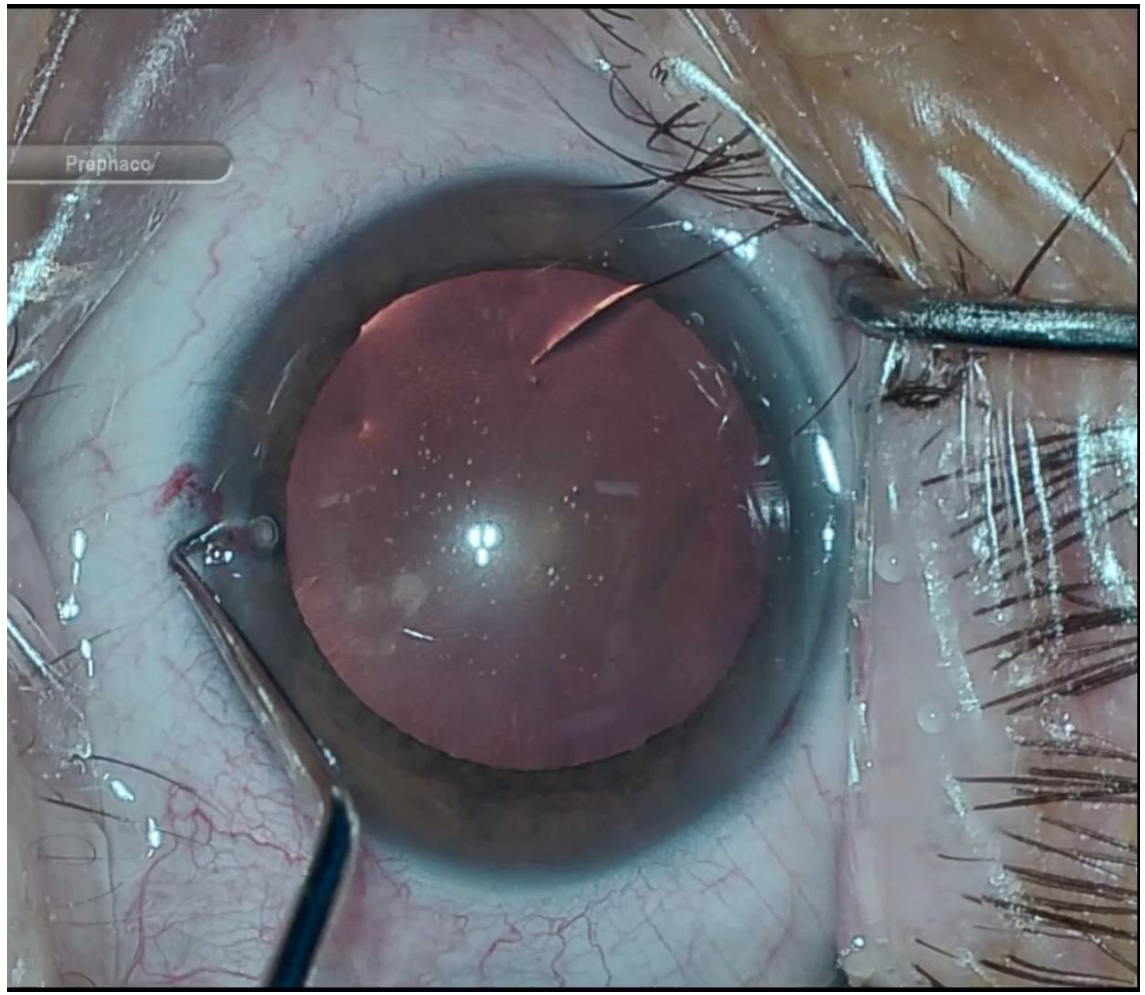
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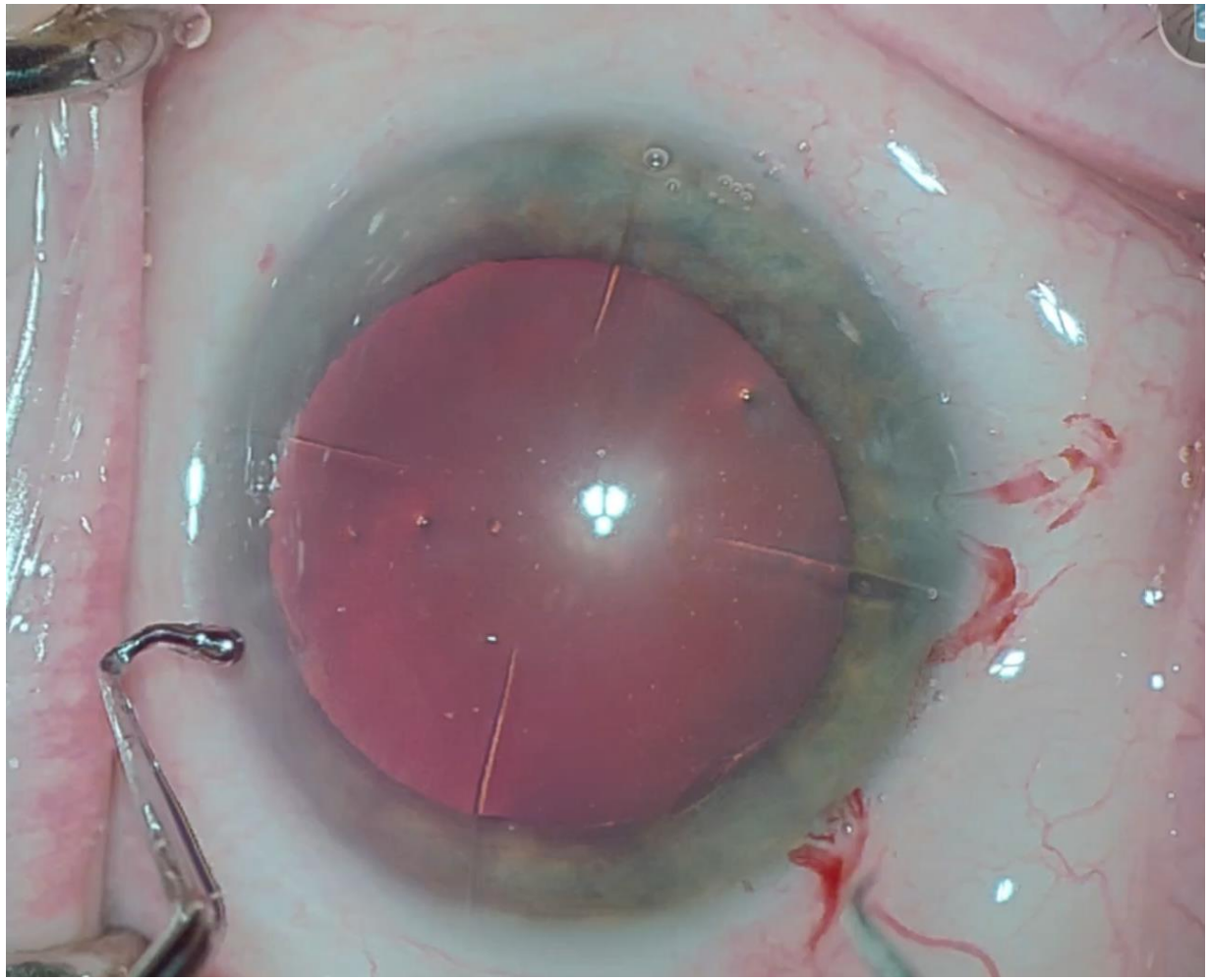
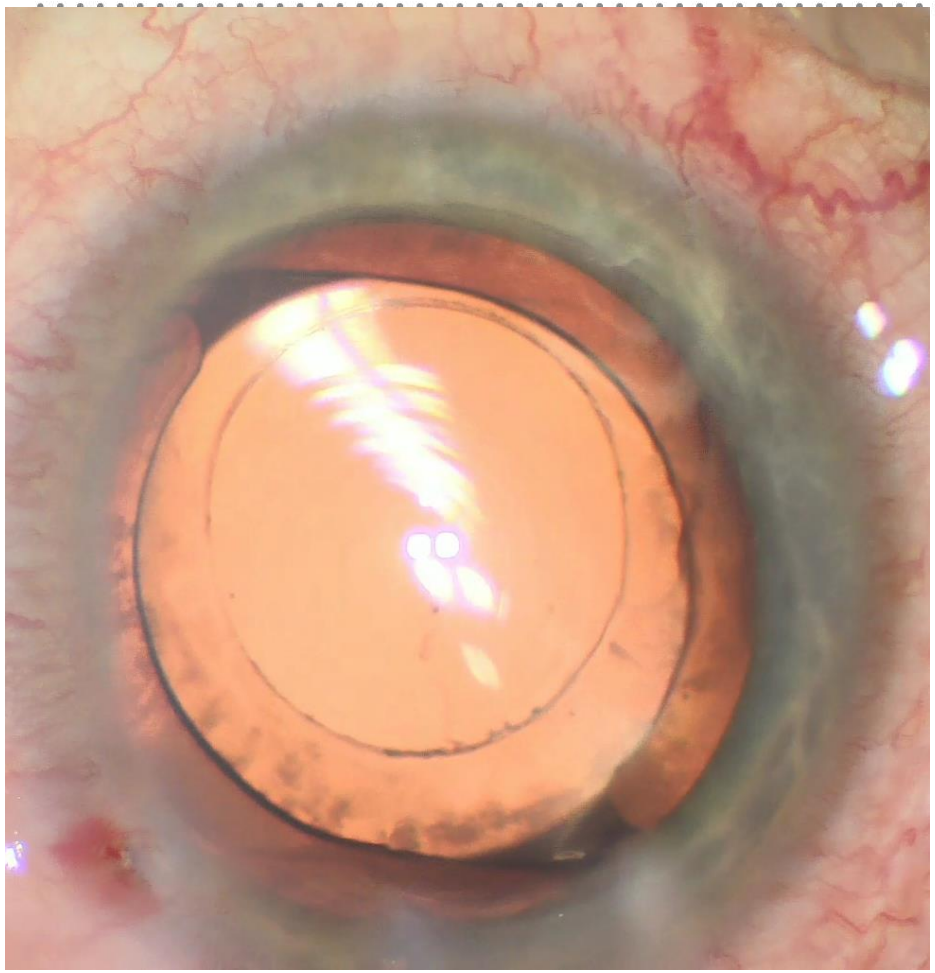
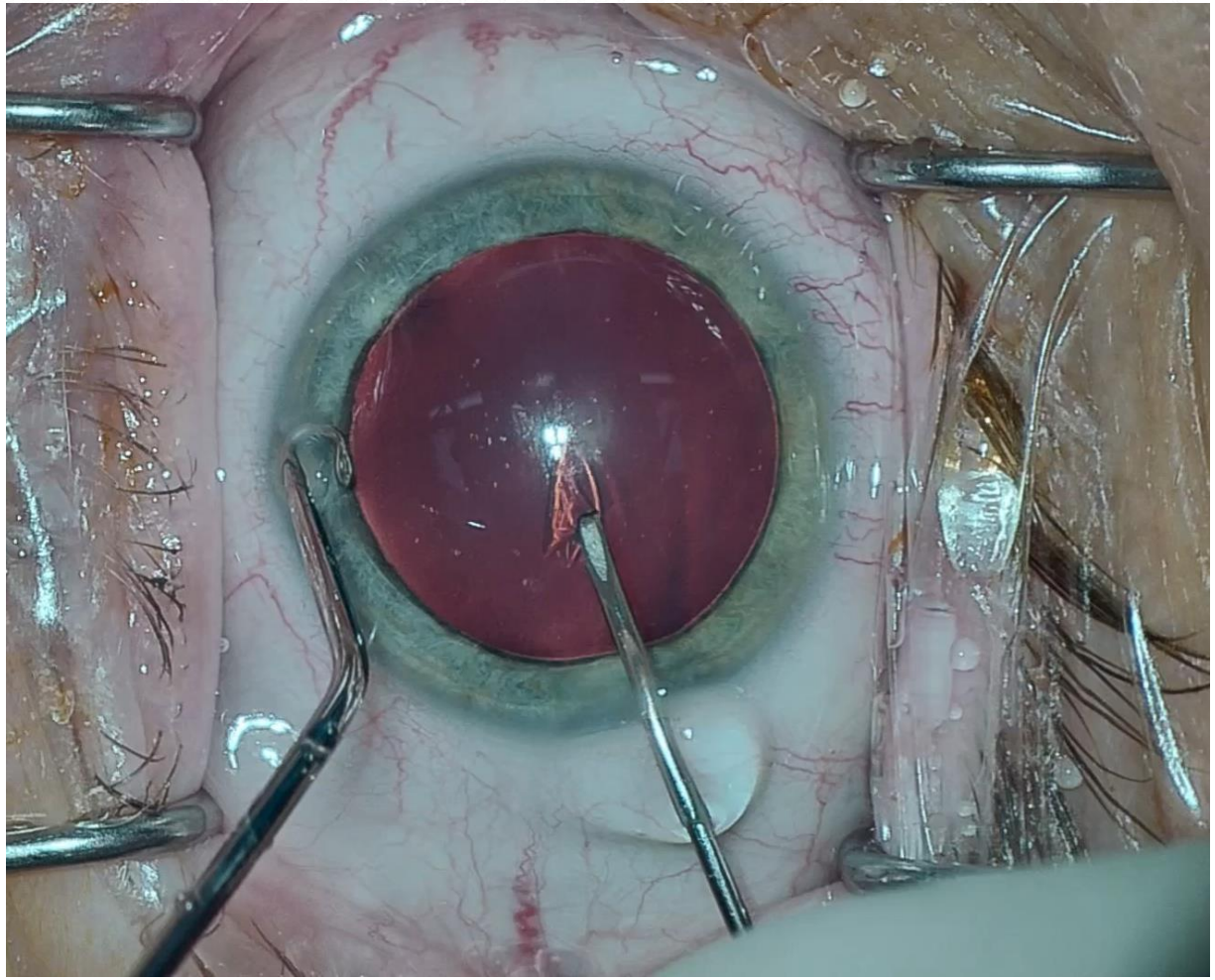


Centration Fiddling





Capsule Polishing

Posterior Capsule Pristine-ing

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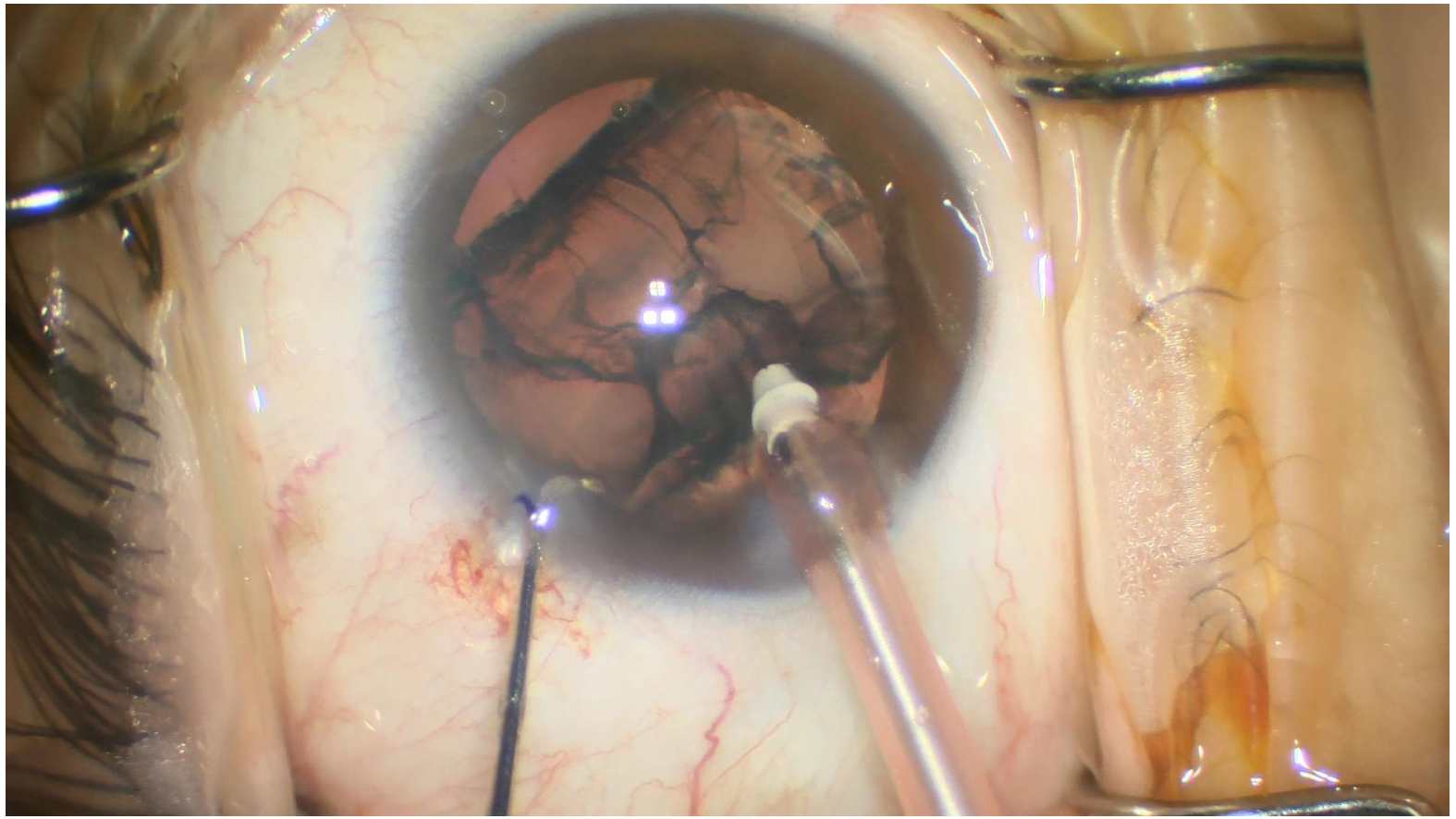

Posterior Capsule Pristine-ing

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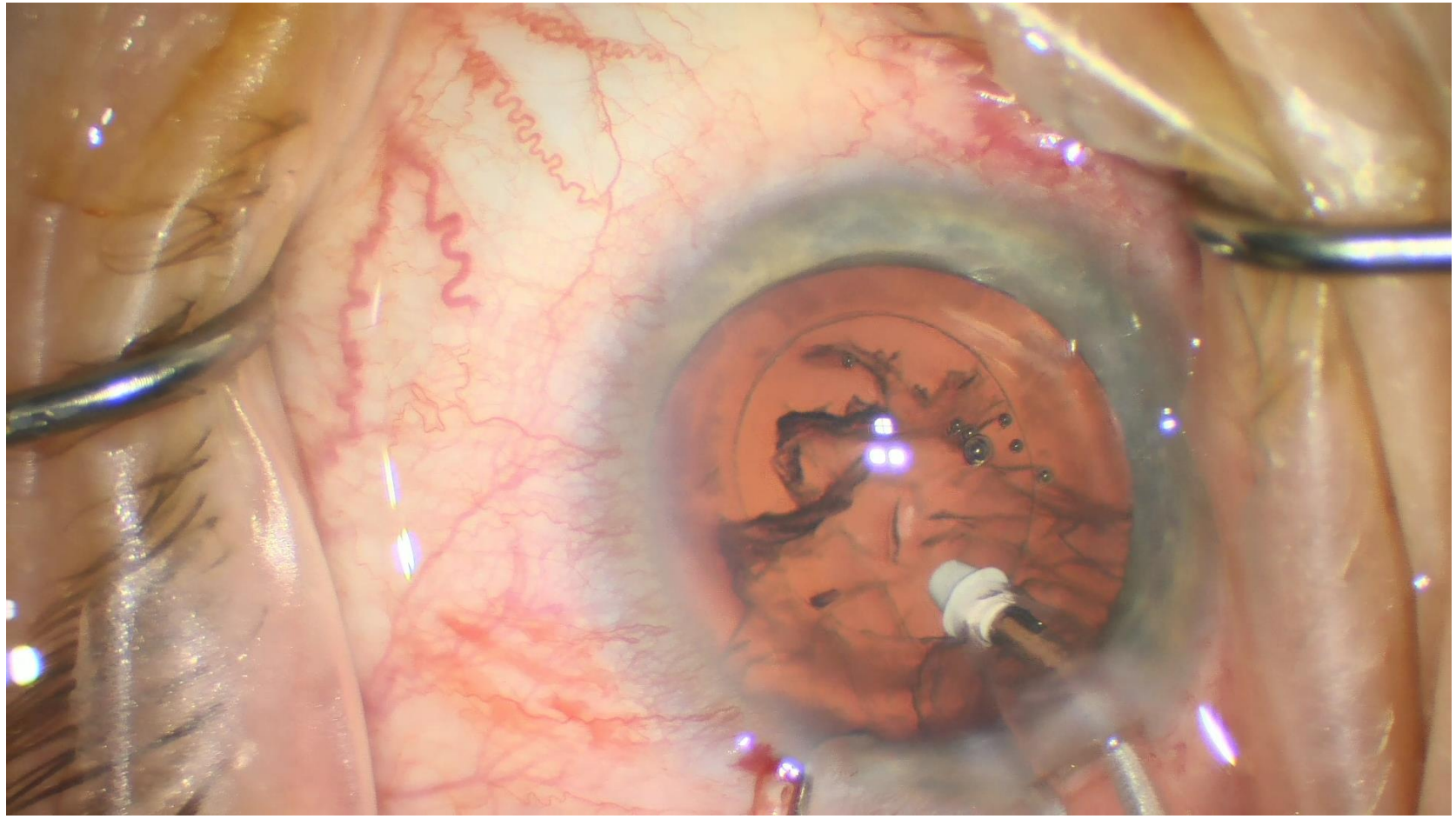

Astigmatism: How low do you go?

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- Toric down to 1D
- Femto AK?
- Manual LRI?
- RxSight:

Intra-operative aberrometry

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Patients often ask…

Doctor, how do you know you put the proper lens in

→

I'm not sure the technician really knew what they were doing when they did their testing

→

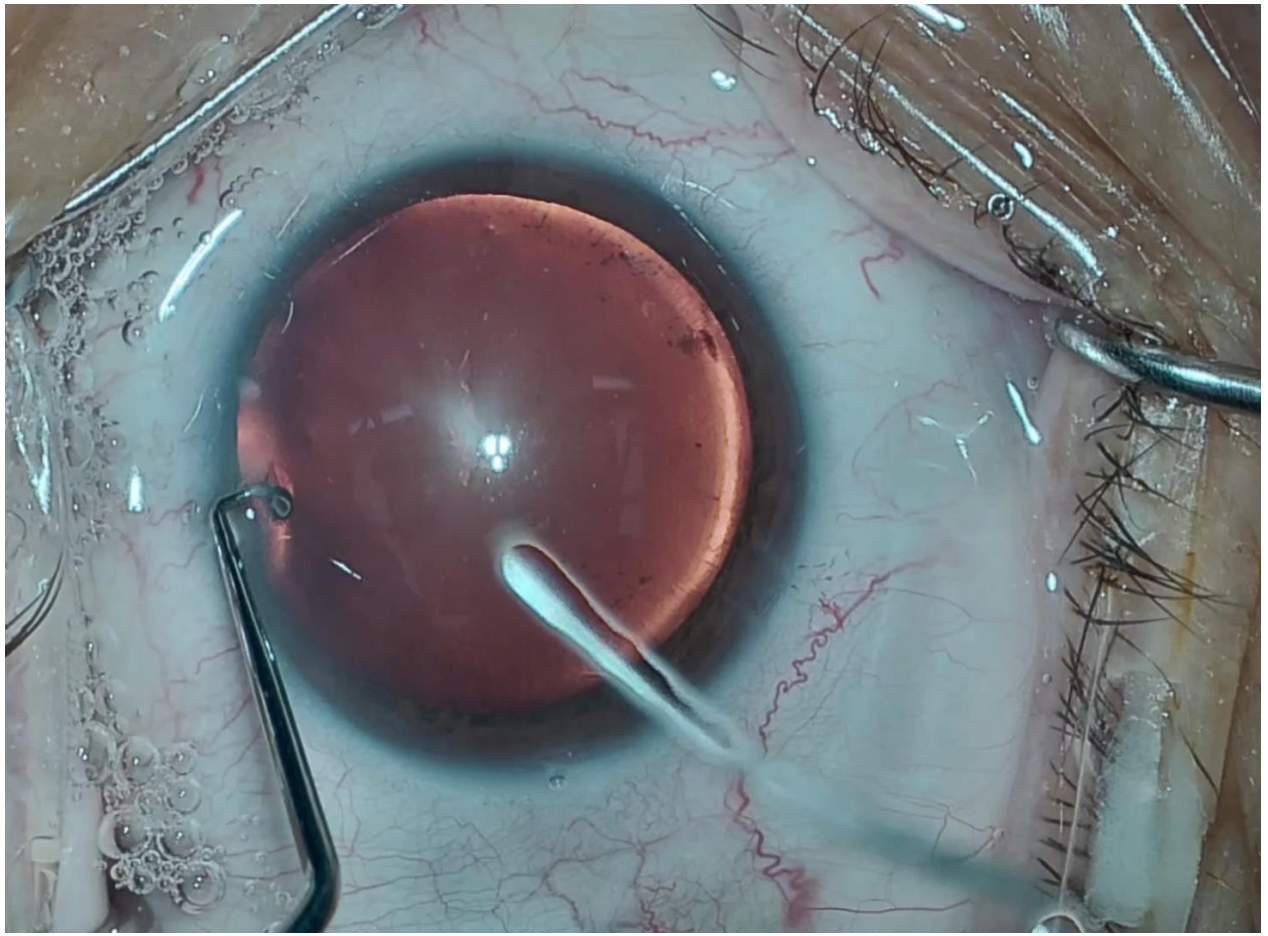
My refraction seems so off because of the cataract… I hope you don't use that when picking my lens

"Don't worry!

We use a machine that uses laser fixation where we take measurements of your eye one more time AFTER the cataract is removed.

And then we REPEAT the measurement of the eye after the new lens is placed to assure it is the CORRECT LENS and that it is in the CORRECT POSITION"

IA Video



How low do you go for cyl?

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- Studies show that patients are “happy” with .5D (or less)
- To achieve .50 cyl (or less)
  - Must aim for zero

Premium IOLs

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- Require unique consideration
- Patient's expectations are higher
- Ideal performance requires ideal positioning

Conclusion: Premium IOL Surgery

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- **Centration**
- **Capsule coverage over IOL**
- **Control Astigmatism**
- **Delay Yag laser: Capslue polish**