FORMULA TO SUCCESS

The Influence of Cataract Outcomes Based on Biometry & Calculations

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MY MISSION:

- How to make biometry interesting and engaging at 4 pm on Friday…

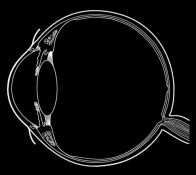
Please visit download the Kahoot! app or visit **www.kahoot.it**

Kahoot test

WHAT IS BIOMETRY?

- Bio – biological tissue
- Metry – measurement of

- Cornea
- Anterior Chamber
- Lens
- Vitreous
- Retina
- Overall length of the eye



A SOLID FOUNDATION

- Dry eyes
- Poor positioning
- History of refractive surgery
- Previous eye surgery
- Busy clinic
- Software update
- Unfamiliar equipment

POTENTIAL ERRORS IN IOL OUTCOMES

- Intra-operative:
  - Insertion of an incorrect IOL (wrong patient, wrong eye, wrong procedure)
  - Incorrect labeling or packaging of the IOL by the manufacturer or defective IOL (rare)
- Pre-operative:
  - Inappropriate surgeon selection of refractive target
  - Incorrect axial length or keratometry measurements
  - Use of the incorrect A-constant
  - Transcription or data entry errors into the IOL power calculation program
  - Use of an outdated or inaccurate IOL power calculation formula
  - Calculation of IOL insertion for the incorrect patient or incorrect eye

OPHTHALMIC BIOMETRY REALITIES

- 50% of a surgeon's post operative surprises are A-Scan errors (Thomas Olsen, MD)
- Errors of 2.00 D or more are almost always biometry related
- 67% of the time errors are A/K based

(Jack Holladay, MD; Journal of Refractive Surgery 2007)

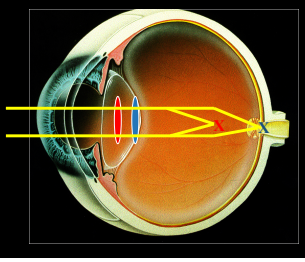
PRESENTATION OVERVIEW

- **Biometry**
  - **Measurements**: components and troubleshooting
  - **IOL Calculations**: evolution of options and selecting the appropriate equation
- **Special Cases**
- **Interactive Examples with Q&A**

Thank you to Denice Barsness, CRA, COMT, CDOS, FOPS and Dr. Lori Lombardi for use of their slides

TWO COMPONENTS OF "BIOS"

1. Measurements
   - Axial eye length
   - Keratometry
2. IOL Calculations
   - Many equations to choose from
   - All seek to account for "effective lens position"

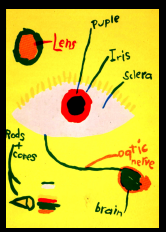


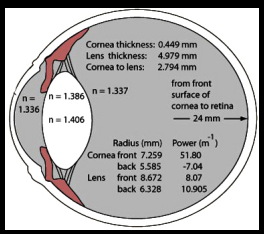
MEASUREMENTS

BEFORE YOU BEGIN

- What is the patient bringing to the table?
- Do you have sufficient information on the patient?
- What is the best "game plan" for that type of patient?
- Know your anatomy as a reference point from which to proof your work

KNOW YOUR ANATOMY





BROAD BRUSHSTROKES

Review refraction & VA to make preliminary assumptions

- Long eye?
- Short eye?
- Steep K?
- Flat K?

FACTORS AFFECTING MEASUREMENTS & IOL CALCULATIONS

- Keratometry
- Axial Eye Length Measurement
- Axial Length Correction Factor (when using optical coherence biometry (OCB))
- Density of Cataract
- Surgical Technique
  - Site implantation
  - Postoperative change in corneal curvature
  - Capsulorrhexis
  - IOL tilt and decentration

THE "NORMAL" EYE AVERAGES

• K Readings	44.00 mm
• Axial	24.00 mm
• ACD	3.25 mm
• Lens Thickness	4.50 mm
• Vitreous	15.50 mm
• Average IOL Power	+21.00 D

AXIAL LENGTH MEASUREMENT

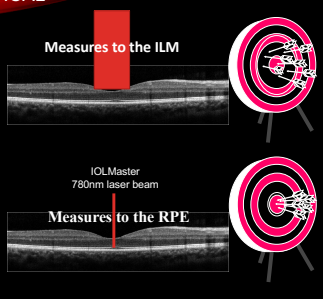
Acoustic

- Applanation
  - Cornea to ILM
  - Prone to compression error – particularly in shorter eyes
  - 1 mm = 1.75 to 3.75 D
  - Must adjust for silicone
- Immersion
  - Minimize compression error

Optical

- More precise
- Cornea to RPE
- Requires:
  - patient fixation
  - clear (enough) media
- Simultaneous measurement of other components

ALIGNMENT PRECISION: ULTRASOUND VS. OPTICAL



A-scan US does not measure to the exact center of the fovea, but samples an area around it due to the broad angle of the U/S beam and

IOLMaster uses a point fixation light, measures along visual axis to the RPE at foveal center and then adds back the foveal thickness.

KAHOOT TIME!

LIMITATIONS OF OPTICAL COHERENCE BIOMETRY

- Limited measurement of axial length in the case of:
  - Corneal scars
  - Dense cataracts, especially posterior subcapsular cataracts
  - Vitreous hemorrhage
  - Any significant media opacity

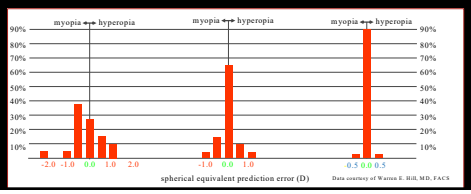
WHERE OCB TRUMPS ACOUSTICAL

- In the presence of posterior chamber silicone
- In the extreme myopic, staphylomatous eye
- In the extreme short, nanophthalmic eye
- In pseudophakic with various types of IOL's with differing designs and properties

Applanation A-scan
falsely short axial length
variable corneal compression
corneal micro-abrasions
highly operator dependent
source of IOL power errors

Immersion A-scan
easier alignment with shell
no corneal contact
improved consistency
less operator dependent
retinal thickness & 10-MHz
wavelength limit accuracy

Partial coherence interferometry
non-contact laser device
phakic, pseudophakic, phakic IOLs
posterior staphyloma, silicone oil
not limited by wavelength
or retinal thickness variations



IOL MASTER 500

- Generates an optical axial length, uses light to measure the axial length
- Ks – 6 points

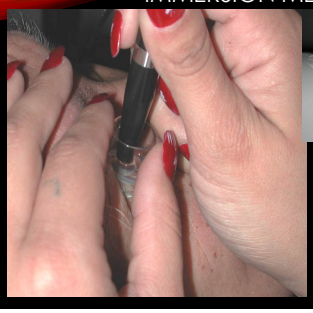
IOL MASTER 700

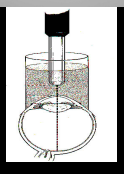
- OCT technology
  - Lens thickness
  - CCT
  - Central retina thickness (qualitative, OCT image)
  - K – 6 points per ring, 3 rings (uses only one ring)
- Equations: Haigis, Holladay II (needs refractive data, including h/o refractive surgery), Barrett

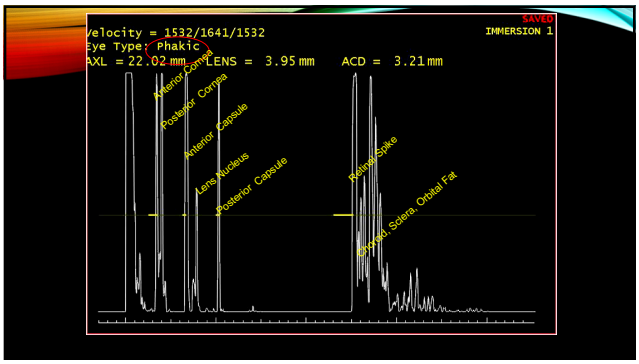
LENSTAR

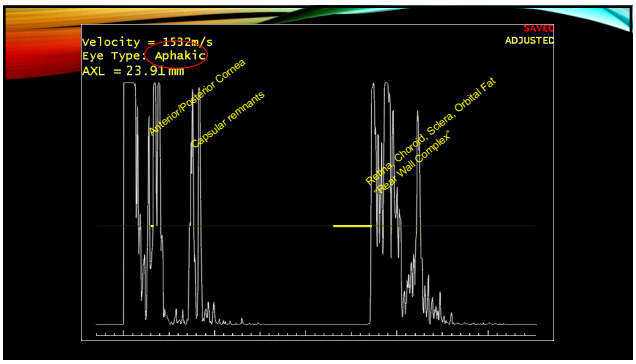
- Optical biometry
- More corneal points
  - 16 points per ring, 2 rings (32 points)
- Lens thickness (LT)
- Central corneal thickness (CCT)
- Retinal thickness (qualitative – spikes)
- Equations: Haigis, Holladay I, Barrett, Olsen (more newer generation formulas)

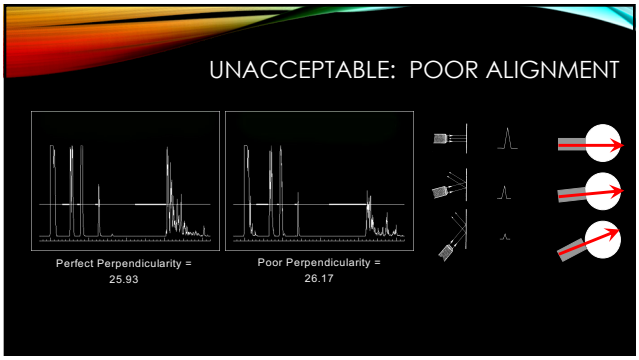
IMMERSION METHOD





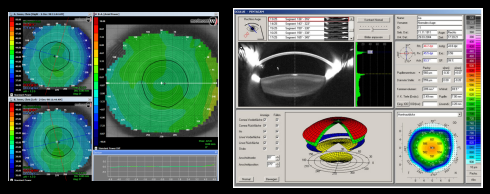






BIOMETRY - KERATOMETRY

- Manual keratometry
- Auto keratometry (Autorefractor, IOL Master)
- Corneal topography – anterior surface curvature
  - Placedo disc (ie Humphrey Atlas, Medmont)
- Corneal tomography – anterior and posterior, 3D analysis/reconstruction
  - horizontal slit scanning, rotational Scheimpflug imaging, arc scanning with very high-frequency ultrasound, and optical coherence
  - Orbscan (slit scanning), Pentacam (Scheimpflug camera)



BIOMETRY PROOF SHEET #1

Measurement	Criteria
Axial	Correct Measurement Mode? (phakic, aphakic, pseudo…)
	At least 5 measurements within 0.5 mm
	OD/OS Axial within .33 mm
	AL consistent with oldest or pre cataract RX
	Immersion: Good, perpendicular echospikes
	OCB: Good waveform (Primary maxima), Double peaks
Keratometry	Ocular surface- requires artificial tears?
	K1 and K 2 readings within .25D in each meridian
	Keratometry astigmatism and refractive cyl ? axis conform?
	Astigmatism for each eye < 3.50 D
	Average K power for both eyes within 1.50 D
	Average K power < 48.00 D or > 49.00 D
ACD Measurement	Aphakic and pseudophakic: do not measure
	OCB: 5 consistent measurements
	ACD < 4.2 mm > 0.2 mm
White to White	3 measurements within 0.2mm
	OD & OS within 0.2mm patient fixating centrally

Source: doctorhill.com

BIOMETRY PROOF SHEET #2

Exception	Additional Task
Axial Length < 22.00 mm or > 30.00 mm	Immersion A scan/ bring to MD attention
Difference in Axial length OD/OS >0.33 mm	Justify, remeasure, bring to MD attention
Astigmatism >3.50 D	Corneal Topography
Average K's : > 1.5 D between eyes	Justify, remeasure, bring to MD attention
Average K power >48.00 D or <40.00 D	Justify, remeasure, bring to MD attention
ACD < 2.2 mm or > 4.2 mm	Justify, remeasure, bring to MD attention
White to White < 10.2 or >12.9	Remeasure, bring to MD attention

Source: doctorhill.com

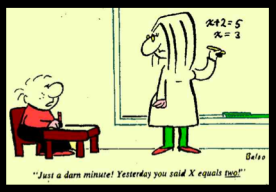
IOL CALCULATIONS

KNOW YOUR GOAL!

- Emmetropia
- Intermediate
- Near

- Monovision
- Mini-monovision

- Other rare goals (for anisometropia):
  - High myopia
  - Hyperopia



REFRACTIVE TARGET

- 60 yo F with 3+ NSC OU
- MRx
  - OD -6.00 +2.00 x 172 20/50
  - OS -5.00 +1.50 x 002 20/40

- What questions do you want to ask about her life?
  - Do you read with your glasses off?
  - Are you okay with reading glasses?
  - Hobbies?
  - How long have you been in glasses?
  - Other tasks you do without glasses?

ANISOMETROPIA

- How much anisometropia is tolerable?
  - 2.5-3.0 D
- Astigmatic anisometropia?
  - 1.50 D astigmatic anisometropia

- 2% image size change per diopter.
- Brain cannot adjust to 6% image size difference

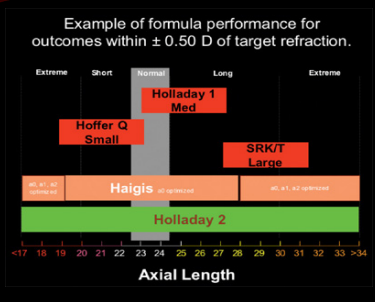
SURGICAL GOAL

- Success = % refraction within 0.5 diopters of target

- Success is reduced in patients with:
  - Unusual anatomy (ie. nanophthalmos)
  - High myopes and high hyperopes
  - h/o ACG
  - s/p Laser vision correction (Lasik, PRK, RK)

EVOLUTION OF EQUATIONS

- Theoretical vs regression analysis vs combination
- SRK: Power = A – 0.9K– 2.5(axial length)
  - SRK II, SRK-T
- Haigis: uses ACD measurement, statistical analysis of post-op results → individualized
- Holladay II: aggregate of 50,000 cases; uses ACD, HWTW, pre-op refraction, lens thickness, age
- Barrett Universal: uses estimates of posterior corneal astigmatism
- Hill-RBF: optimized for Lenstar



CHECKING YOUR BIOS

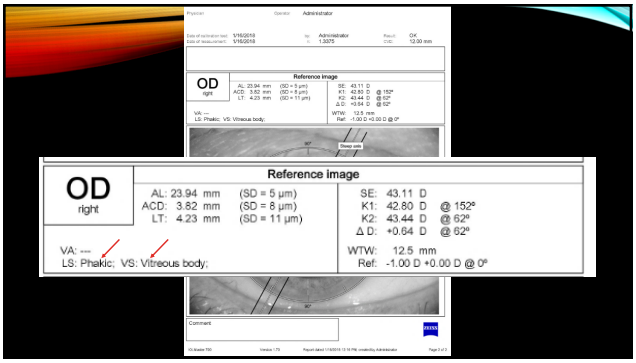
- Check the patient's name and date
- Check to be sure that you are looking at the surgical eye
- Check AL for absolute number and symmetry
- Check Ks for absolute number and symmetry
- Check target refraction compared to your plan
- Check the equation you are using (Haigis, Holl, etc)
- Check to be sure you are choosing the correct lens
  - (SN, SA, MA etc – don't just check what you are accustomed to looking at)

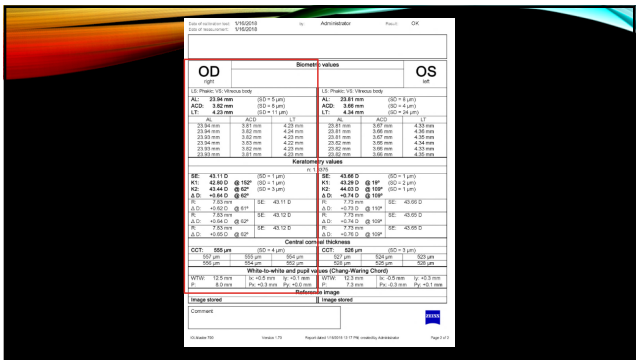
AVOID SIMPLE ERRORS!!

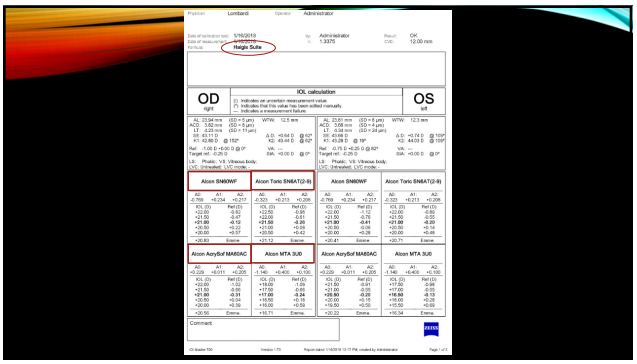
- Simple transfer data errors
  - Correct patient, correct eye
- Ignorance of post-refractive surgery status
- Measuring patient with CL on
- IOL for wrong patient
- Expecting your standard IOL in one place on the biometry sheet (always top left, photographer may switch your IOLs around)

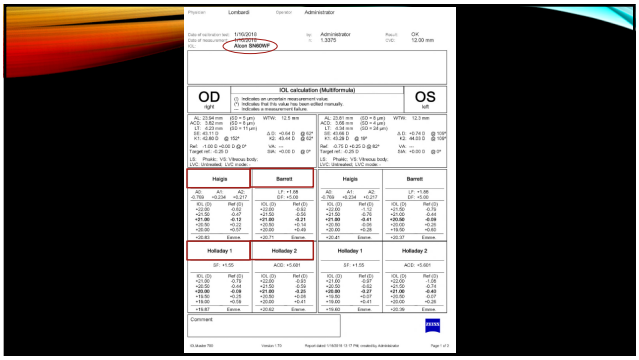
WHEN TO CONSIDER REPEAT BIOMETRY

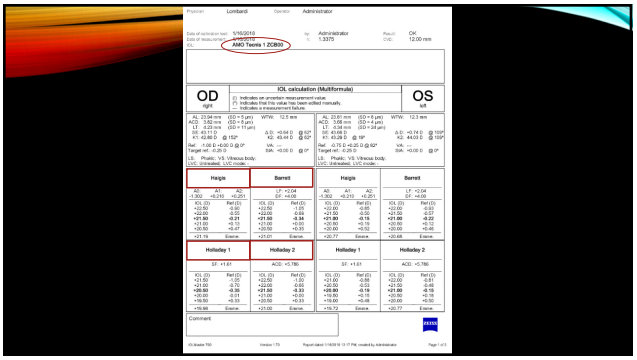
- Axial length: <22.00 mm or >25.00 mm in either eye
- Difference in AL >0.33 mm (if not correlated with patient's oldest MRx)
- Possible staphyloma or variable AL measurements
- K's <40 D or >48 D
- Previous keratorefractive surgery
- Axial length or K's don't correlate with pts refractive error and or topography
- There is a difference in IOL or K power between eyes of > 1 D

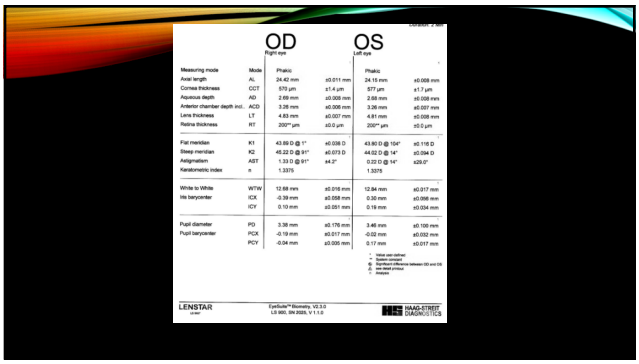


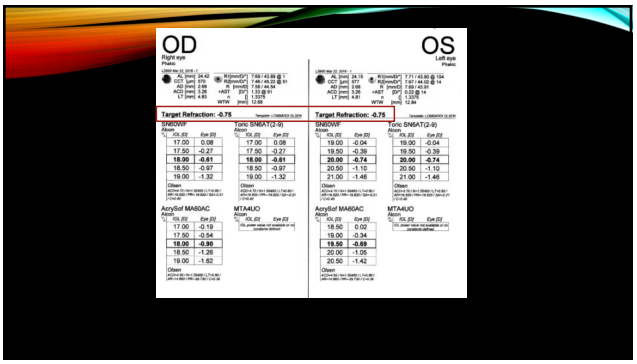






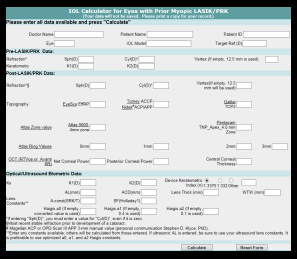






POST-REFRACTIVE IOL CALCS

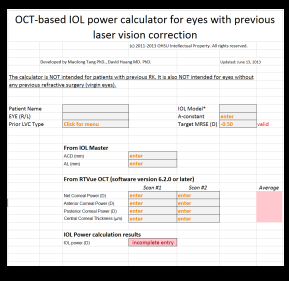
- http://iolcalc.org/
- Prior MYOPIC vs HYPEROPIC – know this (SE)
- Preop: -1.00 +3.50 x 92 → SE +0.75, patient had hyperopic LASIK



COOL LAB – DR HUANG

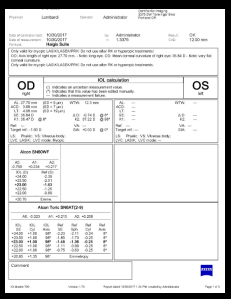
HTTP://COOLLAB.NET/INDEX.PHP?ID=852

- OCT based



IOL MASTER

- Haigis-L formula
  - Select Myopic
  - vs Hyperopic LASIK



A WORD OF CAUTION

"Tolerance stacking"

- Axial length off by .25mm
- Keratometry off by .25D
- IOL power by manufacturer +/- .25D
- Surgical technique? Position in capsule?
- .25 + .25 + .25= can equal those nagging .50 to .75 "failures to reach target"
- The large errors are easy to spot- the little things adding up, not so easy to pin down……

KAHOOT TIME!

	Axial Length	Averaged K's	VA	ACD/ LT	Lens Power
OD	23.88	43.56	HM	3.33/ 4.13	21.08
OS	23.30	43.50	CF	3.21/3.13	21.97

Why a higher power IOL OS?

SPECIAL CASES

SHORT EYES

Beware of short eyes (~21 mm).
- Use the right formula – ie Haigis or Hoffer (not SRK's)
- Raise the bar on biometry

- Larger errors in previous equations (SRK-T) because supposed that these eyes had short anterior segments.
- ELP much more important for short eyes than long eyes since high IOL powers vs low IOL powers for long eyes

LONG AXIAL LENGTH

- Wang-Koch modification of axial length to prevent hyperopia
  - Wang L, et al. Optimizing intraocular lens power calculations in eyes with axial lengths above 25.0 mm. JCRS 2011; 37:2018-2027.
  - Optimized Optical Biometry AL = (0.8289 x measured AL) + 4.2663
- Barrett Universal formula (no AL adjustment)

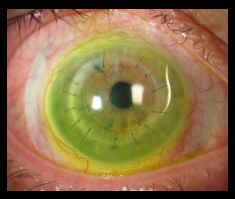
SCLERAL BUCKLE

- If AL is greater than 24.0 mm, reduce the IOL power by 0.50 D in the setting of a scleral buckle
- S.B. increases A.L. by 0.75 mm to 1.25 mm with a moderate scleral buckle, but *the ACD stays the same.*
  - Most IOL power calculation formulas assume greater AL means greater ACD (except Holladay 2, which asks if a scleral buckle is present)
  - Subtracting 0.50 D from the calculated IOL power will correct for this.

POSTERIOR STAPHYLOMAS

- Incidence increases with increasing axial length:
  - 27.5 – 28.4 mm 4.80%
  - 28.5 – 29.4 mm 14.63%
  - 29.5 – 30.4 mm 32.88%
  - 33.5 – 36.4 mm 71.43%
- May cause hyperopic surprises
- The most posterior portion of the globe may not correspond to the macula
- Ask for B-scan U/S concurrent to A-scan
- Optical Coherence Interferometry (IOL Master)

COMBINED PKP/IOL



- Use average K of 44 D
- Use K's of clean, fellow eye if available
- Use K's of past history if usable

TOP 10 BEST HABITS FOR BEST BIOMETRY

1. Triage appointments BEFORE scheduling to allow sufficient time for "surprises". Categorizing loosely as "Routine" or "Difficult" will provide sufficient time for thorough investigation
2. Don't be rushed or distracted. Schedule accordingly
3. Good pre op review of data before measuring patient
4. Have more than one trained tech on hand for second opinion
5. Always compare measurements between eyes
6. Use multiple means of measurements where applicable
7. Apply "Does it Make Sense" rule to all data WHILE patient is still available for re check where indicated
8. OCT of macula as pre op baseline and/or to explain results
9. Diagnostic B scan when readings are not reproducible and/or patient is 20/400 or less
10. Accurate pre op proofing of date BEFORE patient leaves the exam. Proof in a quiet, non distracting environment

CASE EXAMPLES

CASE STUDY #1

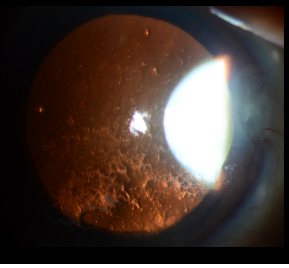
	Axial Length	K's	VA	ACD/ LT	Lens Power
OD	26.56	44.00/47.50	20/100	3.04/4.82	+11.13
OS	23.88	44.50/45.75	20/20	3.04/4.95	+20.57

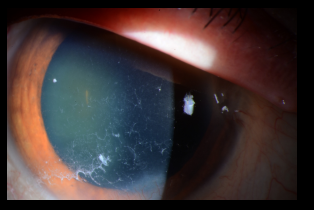
Why a such a low power IOL OD?
Why 2.68mm difference in axial length?
Why such steep K's OD?

CASE STUDY #2

	Axial Length	K's	VA	ACD/ LT	MRx
OD	23.34	unreadable	20/200	4.08/3.61	-1.50 +1.00 x 085
OS	23.39	45.00 x88 45.75 x178	20/60	3.95/3.82	-1.50 +1.00 x 085

CASE STUDY #2, CONT'D





CASE STUDY #2

	Axial Length	K's	VA	ACD/ LT	MRx
OD	23.34	unreadable	20/200	4.08/3.61	-1.50 +1.00 x 085
OS	23.39	45.00 x88 45.75 x178	20/60	3.95/3.82	-1.50 +1.00 x 085

How do you proceed?

CASE STUDY #3

- Patient is a 74 year-old woman with history of cataract surgery OS
- Happy with result, wishes to proceed with OD

	Axial Length	K's	VA	MRx
OD	29.97 (optical) 29.98 (immersion)	40.10 x 4/41.90	CF	-1.00 +4.00 x 92
OS			20/25	-0.75 +1.25 x 90

What additional information is needed?

THANK YOU FOR YOUR ATTENTION

What questions do you have?