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JCAHPO Regional Meetings

2017

JCAHPO
JOINT COMMISSION ON ALLIED HEALTH PERSONNEL IN OPHTHALMOLOGY®

Biometry and IOL Calculations

ASCRS and ASOA Symposium and Congress
Los Angeles, CA

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  - Empire Eye and Laser Center Bakersfield, CA
- Financial Disclosure
  - Abbott Medical Optics, Allergan, Carl Zeiss Meditec, ClarVista Medical, Mynosys Cellular Devices, Omega Ophthalmics, Rapid Pathogen Screening

Faculty

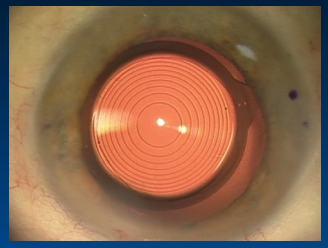
- Jacqueline N. Whinery, CCRC, COA
  - Empire Eye and Laser Center Bakersfield, CA
- Financial Disclosure
  - None

Introduction
Cataract Surgery

- Most common procedure performed in the US
- Approximately 3 million per year
- Accurate preoperative measurements are key to achieving desired refractive outcome, especially with new refractive options

Goals of Cataract Surgery

- Primary - Remove cataract safely and efficiently
- Secondary - Provide best possible visual outcome
  - Spectacle independence?



Tecnis Symfony Toric IOL

Goals of Cataract Surgery

- Visual demands and postoperative expectations may vary, but every successful cataract surgery begins with accurate preoperative measurements
- As an ophthalmic technician, you play a key role in achieving successful outcomes by providing your surgeon with consistent, accurate data
- Understanding Biometry and IOL calculations is the first step

What determines which lens POWER a patient should receive?

Biometry 101

- The measurement of the eye's dimensions, components, and interrelationships

P = A - 0.9K - 2.5L

P = dioptric power of the implanted IOL,

A = constant specific for each lens,

K = average keratometry in dioptres.

L = axial length in mm

SRK Formula

Accurate Preoperative Measurements

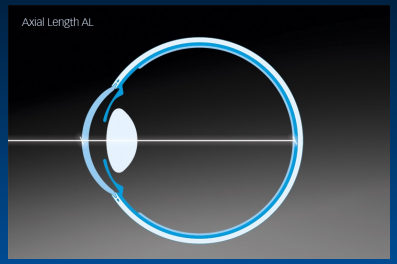
P = A - 0.9K - 2.5L

- Keratometry - a 1D measurement error ~ 1D refractive error
- Axial Length - 1mm measurement error ~ 3D refractive error

A's and K's are most important parameters

Axial Length

- The distance between the anterior surface of the cornea and the fovea



Axial Length

- Normal: 22.0-24.5mm
  - Short eye: < 22mm
  - Long eye: > 26mm

Axial Length
Ultrasound

- In A-scan ultrasound biometry, a crystal oscillates to generate a high-frequency (10-MHz) sound wave that penetrates into the eye

Axial Length
Ultrasound

- When the sound wave encounters a media interface, part of the sound is reflected back toward the probe
- These echoes allow us to calculate the distance between the probe and various structures in the eye

Axial Length
Ultrasound

- Ultrasonography does not measure the distance, but rather the time required for a sound pulse to travel from the cornea to the retina

Axial Length
Ultrasound

- The speed of sound varies in different parts of the eye, and for the purpose of ultrasound biometry, the eye is divided into four areas:
- Cornea (1620 m/s)
- Anterior Chamber (1532 m/s)
- Lens (1641 m/s)
- Vitreous Cavity (1532 m/s)

Axial Length
Ultrasound

- The measured transit time is converted to a distance using the formula **d = t/v**
- distance = time/velocity

Axial Length
Ultrasound

- In applanation biometry, the ultrasound probe is placed directly on the cornea

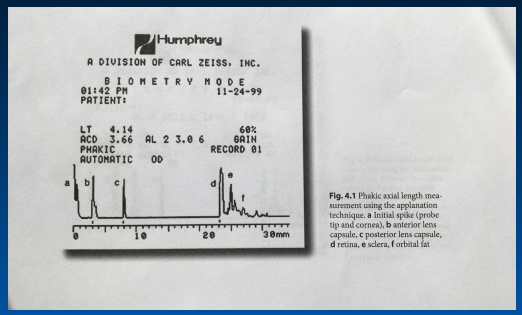


Fig. 4.1 Phakic axial length measurement using the applanation technique. **a** Initial spike (probe tip and cornea), **b** anterior lens capsule, **c** posterior lens capsule, **d** retina, **e** sclera, **f** orbital fat

Axial Length
Ultrasound

- In immersion biometry, a saline-filled shell is placed between the ultrasound probe and the eye

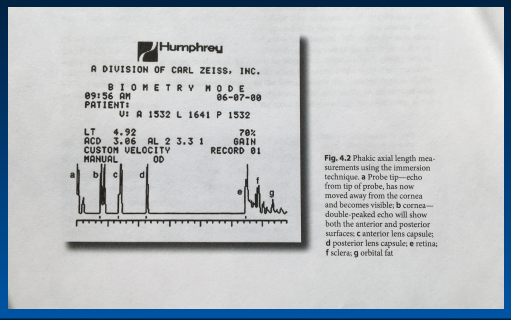


Fig. 4.2 Phakic axial length measurements using the immersion technique. **a** Probe tip—echo from tip of probe, has now moved away from the cornea and becomes visible; **b** cornea—double-peaked echo will show both the anterior and posterior surfaces; **c** anterior lens capsule; **d** posterior lens capsule; **e** retina; **f** sclera; **g** orbital fat

Axial Length
Ultrasound

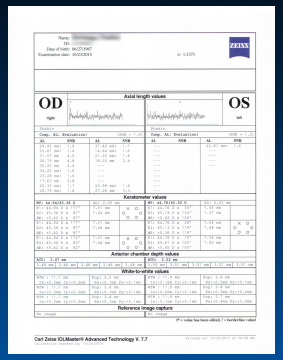
- Errors in measurement with applanation biometry most often result from the probe indenting the cornea and shallowing the anterior chamber, resulting in an overestimation of the IOL power
- Immersion biometry has been shown to be more accurate as it eliminates direct pressure on the cornea

Axial Length
Optical

- Uses reflected light, rather than sound
- Employs a partially coherent wave of approximately 9 times the resolution of the sound wave used in ultrasound
- No contact with the cornea is required

Axial Length
Optical

- Axial Length
- Keratometry
- Anterior chamber depth
- White-to-white

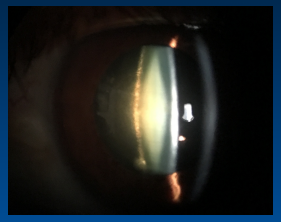


Advantages of Optical Biometry

- Increased precision with minimal training
- Consistency of measurements with multiple operators
- Easier for most patients

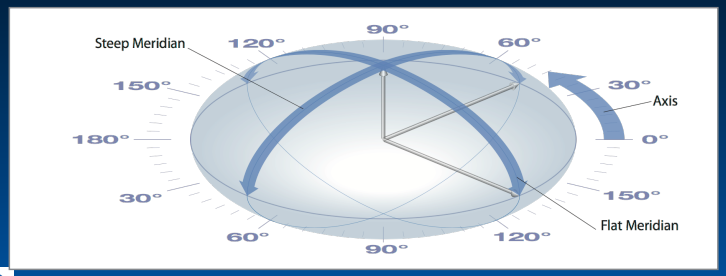
Disadvantages of Optical Biometry

- Limited by media opacity
- Requires patient fixation and cooperation



Keratometry

- Measurement of the anterior corneal curvature at its steepest and flattest meridians



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Keratometry
Manual

- Measures the anterior corneal surface, but uses a fudge factor in the index of refraction (1.3375 vs. 1.376) to account for the posterior corneal power
- Measures only a small area of the cornea (2 points at the 3-4mm zone)
- Susceptible to focusing and misalignment errors
- Mire distortion prevents accurate measurement of irregular corneas

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Keratometry
Corneal Topography

- Performed by projecting multiple illuminated rings onto the corneal surface, the reflected image is then captured, digitized, and analyzed, and the data is displayed in various topographic maps
- Corneal topography addresses some of the limitations of manual keratometry by providing more data from a larger area of the cornea and is especially helpful in evaluating irregular astigmatism

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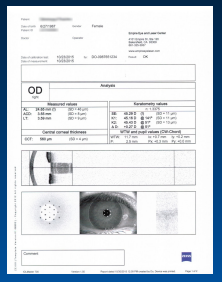
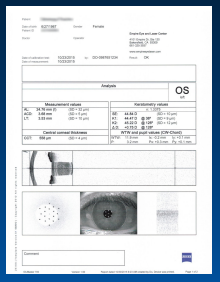
Keratometry
Optical Biometry

- IOLMaster and LENSTAR both provide accurate keratometry readings





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Axial Length

IOLMaster 500 (Zeiss)

- Partial Coherence Interferometry
- Axial Length
- Keratometry
- Anterior chamber depth
- White-to-white

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Biometry

LENSTAR 900 (Haag Streit)

- Low Coherence Optical Reflectometry
- Axial length
- Keratometry
- Anterior chamber depth
- White-to-white
- Corneal thickness
- Lens thickness

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Biometry

IOLMaster 700 (Zeiss)

- Swept-Source Optical Coherence Tomography (SS-OCT)

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Biometry

IOLMaster 700 (Zeiss)

- Axial length
- Keratometry
- Anterior chamber depth
- White-to-white
- Central corneal thickness
- Lens thickness

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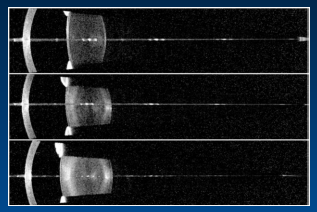
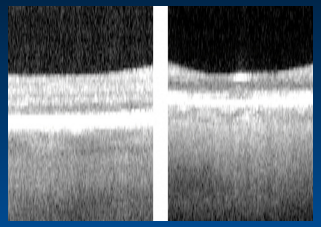
Biometry
IOLMaster 700 (Zeiss)

- Provides a full-length B-Scan image of the eye, as well as a 1mm horizontal retina scan "fixation check"





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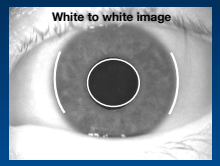
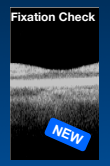
Biometry
IOLMaster 700 (Zeiss)





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Improved cataract penetration

IOL Formulas

- History
- In 1949, Dr. Harold Ridley implanted the first IOL, with a postoperative refractive surprise of nearly 20 diopters
- In the early 1970s, the state-of-the-art for estimating IOL power for emmetropia was to simply add +19.0D to the patient's spectacle correction
- Even in the 1980s, it was considered acceptable to be within +/- 1.0D of the intended postoperative refraction

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IOL Formulas
1st Generation

- In 1982, the first linear regression formula, based on retrospective analysis of actual postoperative data, known as SRK (Sanders, Retzlaff, Kraff), was introduced

$$P = A - 0.9K - 2.5L$$

P: Calculated IOL power; A: A-constant of IOL; K: Power of cornea; L: Axial length of the eye

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IOL Formulas
1st Generation

- SRK was easy to use, requiring only a calculator, but proved inaccurate for long and short eyes

IOL Formulas
2nd Generation

- Brinkhorst, Hoffer
- SRK II, listed manual correction factors for long and short eyes

IOL Formulas
3rd Generation

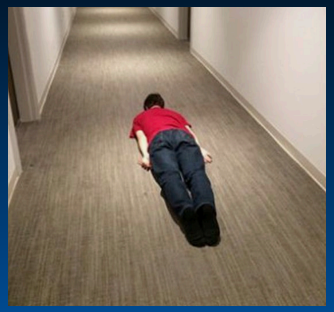
- These formulae estimate the position of the IOL within the eye
- Holladay (1988)
- SRK/T (1990)
- Hoffer-Q (1992)

IOL Formulas
4th Generation

- Use additional biometric parameters, such as ACD, WTW, lens thickness, refraction, age
- Holladay II
- Olsen
- Barrett Universal II
- Haigis

NOW WHAT?

- That was a lot of information
- I'm not sure what to do with it...



How to Choose?

- Availability
- Accuracy
- Familiarity

How to Choose?
Availability

- What formulas are included on your machine?
- IOLMaster: Haigis, Hoffer-Q, Holladay I & II, SRK II, SRK/T
- LENSTAR: Haigis, Hoffer-Q, Holladay I, SRK II, SRK/T, Masket, Modified Masket, Shammas No-History, Barrett Universal II

How to Choose?
Availability

- Software
- IOLMaster 700: Haigis Suite (Haigis, Haigis-L, Haigis-T)
- LENSTAR: PhacoOptics (Olsen), Holladay IOL Consultant

How to Choose?

Availability

- Online:
- Barrett Universal II - www.apacrs.org/barrett_universal2/
- ASCRS Post-Keratorefractive Online Calculator - www.iolcalc.org

Bottom Line

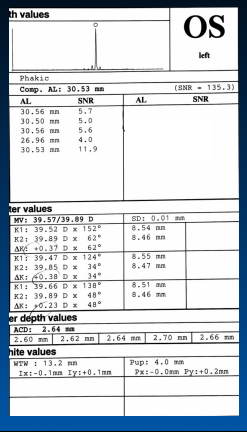
- Current optical biometry technology and 3rd and 4th generation IOL formulas provide consistently accurate IOL power calculations for the majority of patients
- There are a lot of options available, and every cataract surgeon has their own "go-to" formulas, so get to know what your surgeon prefers

Special Considerations

- Long eyes
- Short eyes
- Contact lens wearers
- Previous refractive surgery
- Ocular surface issues
- Premium IOLs

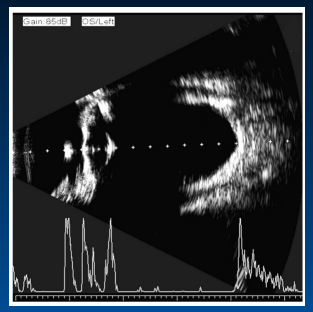
Long Eyes

- Patients with axial myopia (axial length greater than 26mm) are at a greater risk for suboptimal refractive outcomes following cataract surgery
- Standard IOL power calculation formulas frequently select IOLs of insufficient power, resulting in postoperative hyperopia



Long Eyes

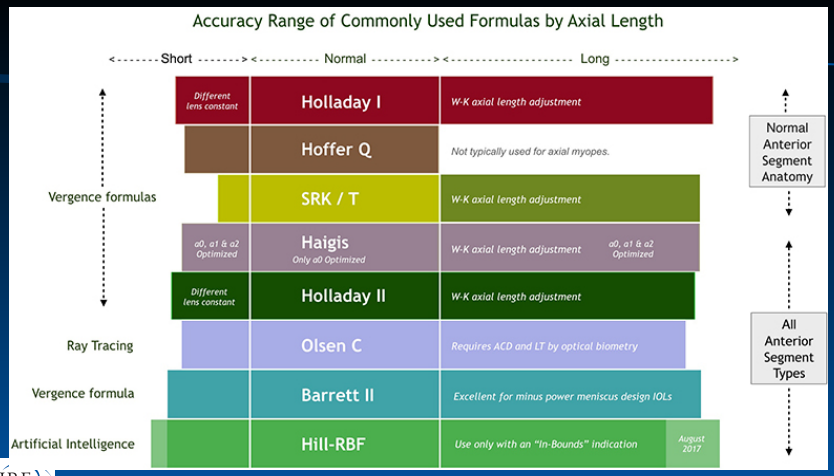
- There are formulas available that adjust the lens constant (Haigis), as well as the axial length (Wang-Koch)
- The Barrett Universal II formula is a thick lens formula, taking into account the changes in optics design of IOLs of different powers
- www.apacrs.org/barrett_universal2/



Yang QH, et al. Int J Ophthalmol. 2014;7(3):441-445

Short Eyes

- Hoffer-Q
- Holladay II (adjust lens constant)
- Barrett Universal II



Previous Refractive Surgery

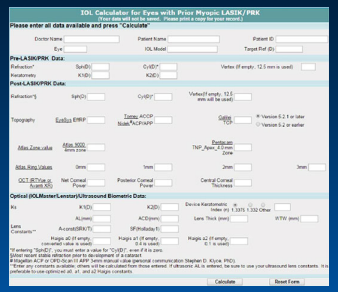
- There are multiple formulas available for post-refractive surgery patients

Previous Refractive Surgery

- Double K Correction Method
- SRK/T Formula Correction Method
- Modified Masket
- Wang Koch Maloney Method
- Clinical History Method
- Hoffer Formula Correction Method
- Shammas No History
- Topographic Central Power

Previous Refractive Surgery

- ASCRS Post-Keratorefractive Online Calculator
- www.iolcalc.ascrs.org



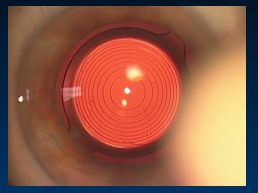
Contact Lens Wearers

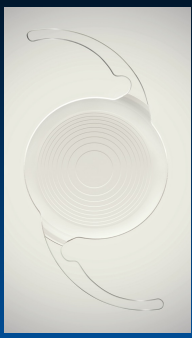
- Discontinue contact lens wear prior preoperative measurements
- At least 3 days for soft lenses
- At least 1 week for toric/EW/RGP lenses
- Advise the patient that additional measurements and additional time out of contacts may be required if variability is noted

Ocular Surface Issues

- Artificial tears
- Restasis/Xiidra
- Punctual plugs
- LipiScan/LipiFlow
- BlephEx

Premium IOLs





- Patient Selection
- Otherwise healthy eye
- Visual demands
- Realistic postoperative expectations
- Financial considerations

Patient Selection

- Otherwise healthy eye
- Retinal pathology
- POAG
- Dry eyes

Patient Selection

- Visual demands
- Job description/duties
- Hobbies
- Personality

Patient Selection

- Realistic Postoperative Expectations
- Preoperative counseling
- Postoperative glasses for some tasks
- Possible LVC enhancement
- Personality

Measure Twice, Cut Once

- Repeat Biometry
- Topography
- Macular OCT
- Variability of repeat measurements may reveal that your patient is not an ideal candidate for a premium IOL

Pearls for the Technician

Case Studies

Conclusion