

# The Promise of No Glasses

## EDOF, PH & Trifocal

### How to Deliver!

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## Financial Disclosure

- I have the following financial interests or relationships to disclose:
  - Abbott Medical Optics: C;
  - AcuFocus, Inc.: C,O;
  - Alcon Laboratories, Inc.: C;
  - ArcScan: C,O;
  - Carl Zeiss Inc: C;
  - Elenza: C,O;
  - M & S Technologies: C;
  - Oculus, Inc.: C;
  - Visiometrics: C,O;

AMERICAN ACADEMY OF OPHTHALMOLOGY WWW.AAO.ORG

The screenshot shows the 'DOCHOLLADAY' section of the website with a list of publications. An arrow points to the fourth item: "Multi Toric Acc IOLs Promise no glasses Biometry for Premium IOLs 16x9 - 2016 (2,934 KB)".

## Total BLUR must be < 0.50 D

- SEQ + CYL < 0.50 D
- 0.25 + 0.25 = 0.50 D
- 0.50 + 0.00 = 0.50 D
- 0.00 + 0.50 = 0.50 D

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## Requirements

- ❶ Centration
- ❷ Accurate Biometry – Optical (IOL Master or LenStar, ...)
- ❸ Accurate K's- Repeatable
- ❹ 4<sup>th</sup> Generation Formula (WTW)
- ❺ Personalized Lens Constant
- ❻ Eliminate Corneal Astigmatism

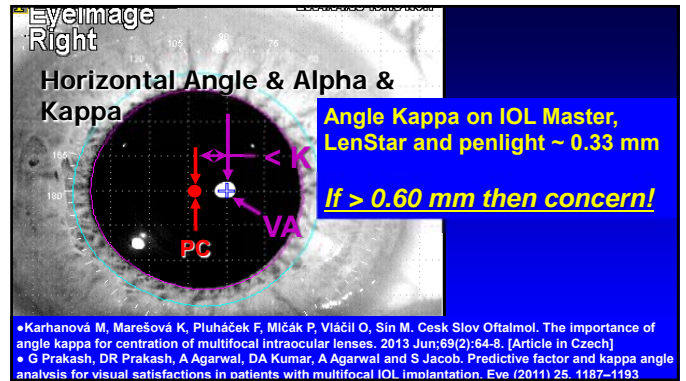
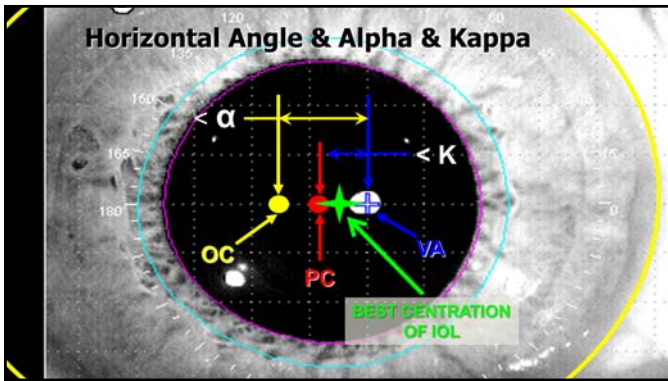
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## Multifocal IOL

### Optimal Location

- Cannot place on Pupil Center & Visual Axis (near P1) where axial ray is perpendicular to foveola.
- Optimal location is different for each patient and ***somewhere between Pupil Center & P1.***

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**LENSTAR – HAAG-STREIT**

White to White	WTW	11.78 mm	±0.083 mm	11.58 mm	±0.054 mm
Iris barycenter	ICX	-0.43 mm	±0.147 mm	0.21 mm	±0.109 mm
	ICY	-0.19 mm	±0.155 mm	-0.22 mm	±0.058 mm
Pupil diameter	PD	3.70 mm	±0.208 mm	3.84 mm	±0.193 mm
Pupil barycenter	PCX	-0.31 mm	±0.032 mm	0.20 mm	±0.029 mm
	PCY	-0.25 mm	±0.039 mm	-0.21 mm	±0.021 mm

**Ignore Sign ... ADD PCX & PCY MAGNITUDES < 0.6 mm**

LENSTAR EyeSuite™ Biometry, V2.1.1 LS 900, SN 2470, V 2.1.0 HAAG-STREIT DIAGNOSTICS

**IOL MASTER 500 – ZEISS Version ≥ 7.1**

Anterior chamber depth values

ACD: 3.13 mm	ACD: 3.24 mm
3.13 mm 3.13 mm 3.13 mm 3.13 mm 3.13 mm	3.24 mm 3.24 mm 3.26 mm 3.24 mm 3.24 mm

White-to-white values

WTW : 12.3 mm	Wp: 3.6 mm	WTW : 12.3 mm	Wp: 3.9 mm
Ix:+0.6mm Iy:+0.4mm	Px:+0.4mm Py:+0.2mm	Ix:-0.8mm Iy:+0.4mm	Px:-0.5mm Py:+0.1mm

**Ignore Sign ... ADD Px & Py MAGNITUDES < 0.6 mm**

Reference image capture

No image No image

(\* = value has been edited, ! = borderline value)

**Optimizing intraocular lens power calculations in eyes with axial lengths above 25.0 mm**

Li Wang, MD, PhD, Mariko Shirayama, MD, Xingxuan Jack Ma, Thomas Kohnen, MD, PhD, FEBO, Douglas D. Koch, MD

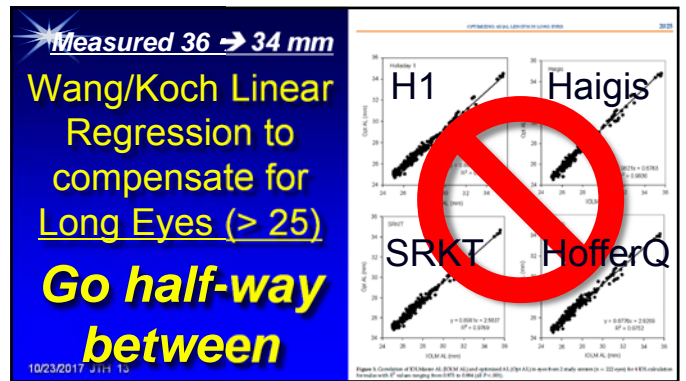
**J Cataract Refract Surg 2011; 37:2018-2027**

**PURPOSE:** To evaluate the accuracy of refractive prediction of 4 intraocular lens (IOL) power calculation formulas in eyes with axial length (AL) greater than 25.0 mm and to propose a method of optimizing AL to improve the accuracy.

**SETTING:** Cullen Eye Institute, Baylor College of Medicine, Houston, Texas, USA, and Department of Ophthalmology, Goethe University, Frankfurt am Main, Germany.

**DESIGN:** Case series.

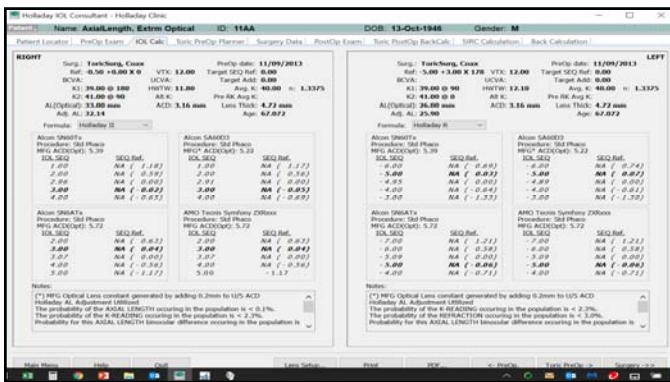
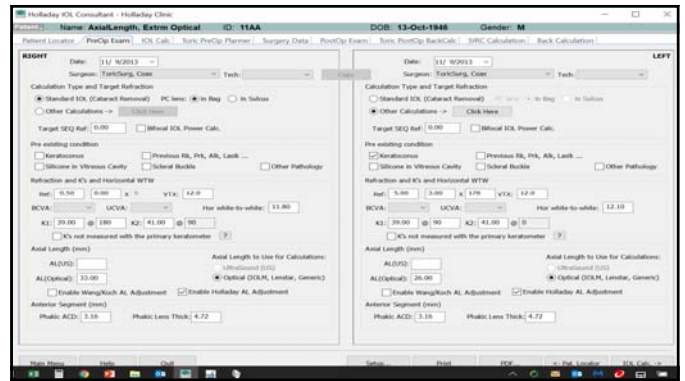
**METHODS:** Refractive prediction errors with the Holladay 1, Haigis, SRK/T, and Hoffer Q formulas were evaluated in consecutive cases. Eyes were randomized to a group used to develop the method of optimizing AL by back-calculation or a group used for validation. Further validation was performed in 2 additional data sets.



## Holladay Non-Linear Regression to compensate for Long Eyes (> 24) (Equal # of + and - prediction errors)

	ALopt	H1 ALadj	H2 ALadj
24		24.00	24.00
25		25.01	24.95
26		25.92	25.90
27		26.77	26.83
28		27.62	27.75
29		28.48	28.66
30		29.34	29.55
31		30.20	30.43
32		31.05	31.30

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### 3. Holladay axial length adjustment in long eyes (> 24.0 mm) for H1 and H2 formulas

A recent study with over 20,000 eyes in the dataset from 146 surgeons has confirmed the finding mentioned by Holladay in their article that the one-center linear regression is aggressive which can result in myopic prediction errors for the Holladay 1 Formula (H2 was not evaluated in Wang/Koch study).

Nonlinear regression analyses were performed for both the H1 and H2 on the large dataset and are less aggressive with a mean prediction error equal to zero. The 1) break point begins at 24.0 mm (the mean of the entire dataset), 2) are not exactly the same for the H1 and H2 and 3) are not linear with the adjustment decreasing slightly as the axial length increases. Because the mean prediction error is zero, there is an equal probability of myopic and hyperopic prediction errors. It is prudent to target for mild myopia (-0.25 or more), since a myopic result is much better tolerated in these patients than hyperopic result.

**Nonlinear Regressions Formulas:**  
 For H1: ALadj = 0.000462655\*ALopt<sup>5</sup> - 0.0070852534\*ALopt<sup>4</sup> + 0.4326542309\*ALopt<sup>3</sup> - 13.1162616532\*ALopt<sup>2</sup> + 199.1238629431\*ALopt - 1190.3984759734  
 For H2: ALadj = -0.0001154786\*ALopt<sup>3</sup> + 0.0032939472\*ALopt<sup>2</sup> + 1.001040305\*ALopt - 0.3270056564

Check:	ALopt	H1 ALadj	H2 ALadj
	24	24.00295901	23.99888908
	25	25.01633523	24.95336584

## Requirements

- Centration
- Accurate Biometry – Optical (IOL Master or LenStar)
- Accurate K's- Repeatable
- 4<sup>th</sup> Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

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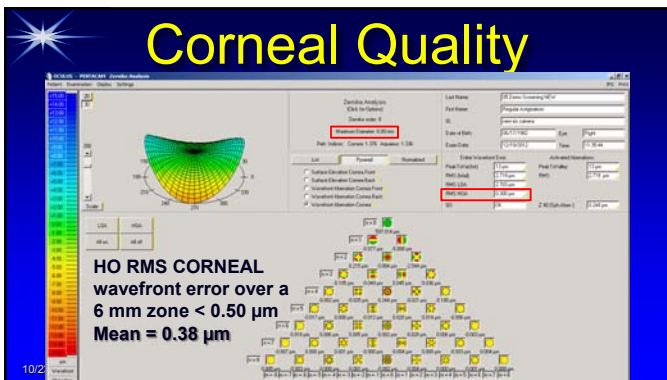
If SD for K's  
 > ± 0.20 D (0.030 mm = 30 μm)

↓  
 Test for Dry Eye  
 ↓  
 ToPography/ToMography

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IOL Master		Keratometer values	
MV: 40.54/42.35 D	SD: 0.00 mm	MV: 40.69/42.56 D	SD: 0.00 mm
K1: 40.54 D x 179°	8.19 mm	K1: 40.64 D x 178°	8.17 mm
K2: 42.35 D x 89°	7.84 mm	K2: 42.56 D x 88°	7.80 mm
ΔK: -1.81 D x 179°		ΔK: -1.92 D x 178°	
K1: 40.54 D x 179°	8.19 mm	K1: 40.69 D x 177°	8.16 mm
K2: 42.29 D x 89°	7.85 mm	K2: 42.51 D x 87°	7.81 mm
ΔK: -1.75 D x 179°		ΔK: -1.82 D x 177°	
K1: 40.54 D x 178°	8.19 mm	K1: 40.69 D x 177°	8.16 mm
K2: 42.35 D x 88°	7.84 mm	K2: 42.56 D x 87°	7.80 mm
ΔK: -1.81 D x 178°		ΔK: -1.87 D x 177°	
Anterior chamber depth values			
ACD: 3.13 mm		ACD: 3.24 mm	
3.13 mm	3.13 mm	3.13 mm	3.13 mm
3.24 mm	3.24 mm	3.26 mm	3.24 mm
White-to-white values			
WTW: 12.3 mm	Pup: 3.6 mm	WTW: 12.3 mm	Pup: 3.9 mm
Ix: +0.6mm	Iy: +0.4mm	Px: +0.4mm	Py: +0.2mm
Ix: -0.8mm	Iy: +0.4mm	Px: -0.5mm	Py: +0.1mm

OD	LenStar Analysis	
right		
Measured values		Keratometry values
AL: 22.30 mm	(SD = 4 μm)	n: 1.3375
ACD: 2.99 mm	(SD = 5 μm)	R: 7.76 mm (SD = 6 μm)
LT: 3.96 mm	(SD = 23 μm)	R1: 7.83 mm @ 156° (SD = 13 μm)
		R2: 7.69 mm @ 66° (SD = 3 μm)
		Δ D: -0.75 dpt @ 156°
Central corneal thickness		White-to-white values
CCT: 542 μm	(SD = 3 μm)	WTW: 11.9 mm Ix: +0.4 mm Iy: +0.2 mm
		P: 4.7 mm Px: +0.4 mm Py: +0.2 mm



## Corneal Quality

HO RMS CORNEAL wavefront error over a 6 mm zone < 0.50 μm

- Normal = 0.38 ± 0.14 μm
- PO Lasik Happy = 0.58 ± 0.21 μm
- PO Lasik Unhappy = 1.31 ± 0.58 μm

McCormick GJ, Porter J, Cox IG, MacRae S. Higher-order aberrations in eyes with irregular corneas after laser refractive surgery. Ophthalmology. 2005 Oct;112(10):1699-709

## IOL Power Calculation

(Zone not Ring – 14K not 24)

- Pentacam can measure FRONT & BACK SURFACE POWER
- Can Calculate:
  - Equivalent K-Reading (EKR65)
    - **65% Mean**, Peak & Average

## IOL Calcs – Abnormal Cornea

(Use 65% MEAN EKR)

- Post Refractive Surgery
- Post PKP
- Keratoconus
- Corneal Scar
- Any Irregular Astigmatism

### Requirements

- Centration
- Accurate Biometry – Optical (IOL Master or LenStar)
- Accurate K's- Repeatable
- 4<sup>th</sup> Generation Formula (7 variables)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

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### Measurements taken for Predictors of ELP Holladay 2, Olsen 2, Barrett 2

① Axial Length	⑤ LT
② Average K (Pre R S)	⑥ Pre-op Ref (Adult before Cat)
③ Horizontal WTW	⑦ Age
④ ACD	

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### CONCLUSION: 9 EYES

Anterior Segment Size	Large	Megalocornea + axial hyperopia (0%)	Megalocornea (2%)	Large Eye Buphthalmos Megalocornea + axial myopia (10%)
	Normal	axial hyperopia (80%)	normal (96%)	axial myopia (90%)
	Small	Small eye Nanophthalmia (20%)	Microcornea (2%)	Microcornea + axial myopia (0%)
		Short	Normal	Long
		Axial Length		

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### Requirements

- Centration
- Accurate Biometry – Optical (IOL Master or LenStar)
- Accurate K's- Repeatable
- 4<sup>th</sup> Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

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### Personalized Lens Constant

- Never use Manufacturer's Constant except to start
- 20 to 40 cases and continue
- Factors
  - IOL Style
  - Lens placement, OVDs
  - Post op medications
  - Biometer, keratometer, ...

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### Requirements

- Centration
- Accurate Biometry – Optical (IOL Master or LenStar)
- Accurate K's- Repeatable
- 4<sup>th</sup> Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

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### Ideal Toric IOL Calcs

- Accurate corneal power and astigmatism ... repeat is SD > 0.020 D (0.030 mm = 30  $\mu$ m)
- Exact Toric Calculator (not a constant ratio of corneal astigmatism to toricity 1.46)
- Proper Surgically Induced Astigmatism (SIA) for incision location and magnitude and axis of PreOp astigmatism ... must account for ATR over 3 to 6 months PostOp
- Results will be greater than 80% within 0.50 D

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### Requirements

- Centration
- Accurate Biometry – Optical (IOL Master or LenStar)
- Accurate K's- Repeatable
- 4<sup>th</sup> Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

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