


On behalf of Vision Expo, we sincerely thank you for being with us this year.

**Vision Expo Has Gone Green!**

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Education Planning Committee considers content and speakers for future meetings to provide you with the best education possible.



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Corneal Hysteresis and IOPcc:  
Glaucoma Vitals for the Modern Era



Justin Schweitzer, OD, FAAO  
Vance Thompson Vision, Sioux Falls, South Dakota  
Optometric Externship Director, Illinois College of Optometry

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Financial Disclosure – Justin Schweitzer, OD, FAAO

- Aeris – C/L
- Alcon – C/L
- Allergan – C/L
- Bausch + Lomb – C/L
- Ocular Therapeutics - C
- EyePoint – C
- Sight Sciences – C/L
- Dimple – C
- Zeiss – C/L
- Visus - C
- Science Based Health - C
- Kala - C
- RVL - C

- Sun – C/L
- Equinox - I
- Reichert - C
- J&J – C/L
- Glaukos – C/L
- Horizon – C
- Corneal – C
- MedPrint – C
- LEC – C/L
- Avelland – C
- Newerla – C
- Netic Scan - C
- Occupire - C

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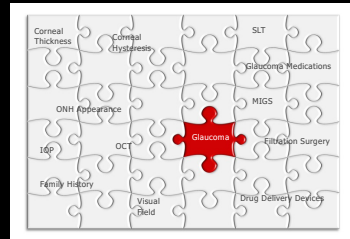
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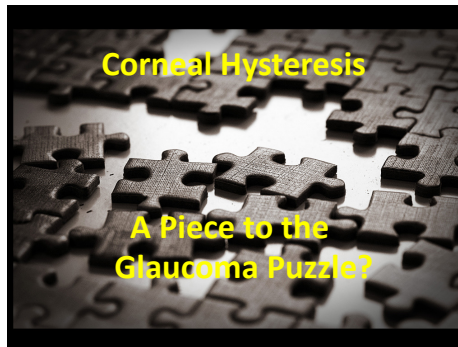
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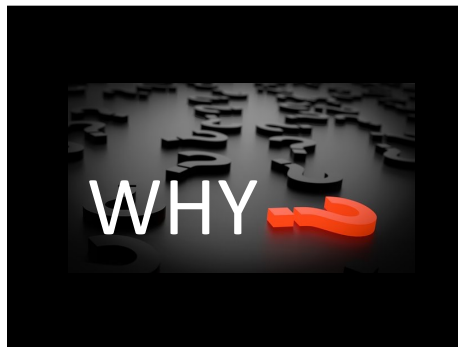
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
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Influences on IOP Measurement




CCT

Post-Refractive

Time of Day

Medications



Physical Activity and Posture

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CCT AS A RISK FACTOR

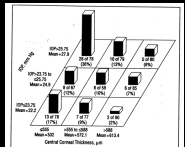



Figure 1. The percentage of participants in the altamirano group who developed glaucoma by IOP range and CCT range. The group is divided by IOP range (mmHg) and CCT range (µm). The percentages are as follows:

IOP Range (mmHg)	CCT Range (µm)	Percentage (%)
10-12.5	525-550	0.0%
10-12.5	550-575	0.0%
10-12.5	575-600	0.0%
10-12.5	600-625	0.0%
10-12.5	625-650	0.0%
10-12.5	650-675	0.0%
10-12.5	675-700	0.0%
10-12.5	700-725	0.0%
10-12.5	725-750	0.0%
10-12.5	750-775	0.0%
10-12.5	775-800	0.0%
10-12.5	800-825	0.0%
10-12.5	825-850	0.0%
10-12.5	850-875	0.0%
10-12.5	875-900	0.0%
10-12.5	900-925	0.0%
10-12.5	925-950	0.0%
10-12.5	950-975	0.0%
10-12.5	975-1000	0.0%
10-12.5	1000-1025	0.0%
10-12.5	1025-1050	0.0%
10-12.5	1050-1075	0.0%
10-12.5	1075-1100	0.0%
10-12.5	1100-1125	0.0%
10-12.5	1125-1150	0.0%
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10-12.5	1175-1200	0.0%
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10-12.5	1375-1400	0.0%
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10-12.5	1475-1500	0.0%
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10-12.5	1550-1575	0.0%
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10-12.5	1750-1775	0.0%
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10-12.5	1875-1900	0.0%
10-12.5	1900-1925	0.0%
10-12.5	1925-1950	0.0%
10-12.5	1950-1975	0.0%
10-12.5	1975-2000	0.0%
10-12.5	2000-2025	0.0%
10-12.5	2025-2050	0.0%
10-12.5	2050-2075	0.0%
10-12.5	2075-2100	0.0%
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10-12.5	2150-2175	0.0%
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10-12.5	2200-2225	0.0%
10-12.5	2225-2250	0.0%
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10-12.5	2275-2300	0.0%
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The Correcting Applanation Tonometer Surface (CATS)



**Journal of Ophthalmology**

Modified Goldmann prism intraocular pressure measurement accuracy and correlation to corneal biomechanical metrics: multicentre randomised clinical trial

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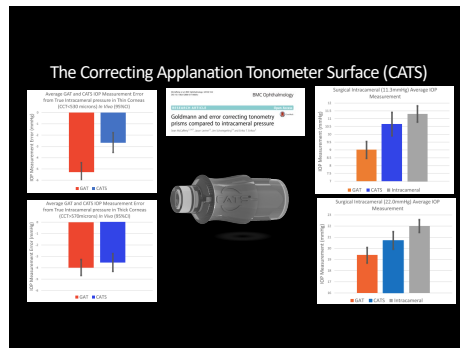
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**Corneal Hysteresis (CH)**

**Corneal Hysteresis reflects the ability of the corneal tissue to dissipate energy<sup>1</sup>**

Function of viscoelastic damping<sup>2</sup>

Provides insight into ocular properties that were not previously understood or conceived of

1. Luo DA. J Cataract Refract Surg. 2005;31:156-162.  
2. Luo DA, et al. J Cataract Refract Surg. 2007;33:1499-1501.  
3. Luo DA et al. Invest Ophthalmol Vis Sci. 2008;49:2819-2825.

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## Intro to Corneal Hysteresis

Viscoelastic tissue with complex, interconnected microstructure

Geometrical attributes are not a surrogate for biomechanical properties

The eye appears to be a mechanical structural continuum

More than 13,000 + papers published on hysteresis

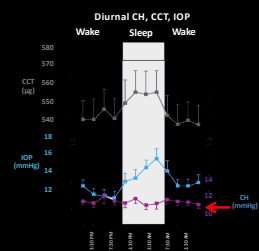
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## Average CH in Normal Subjects

	N	CH
Brazil	105	10.1 $\pm$ 1.8
UK	272	10.2 $\pm$ 1.2
China	125	10.9 $\pm$ 1.5
Japan	204	10.2 $\pm$ 1.3
Spain	88	10.8 $\pm$ 1.5
USA	44	10.5 $\pm$ 1.2

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## CH does not display a 24-hour rhythm<sup>1</sup>



1. Kida T et al. *Invest Ophthalmol Vis Sci*. 2006;47:4422-4426.

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### Corneal Hysteresis, IOP, CCT



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### Show Me the Data



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### Clinical Evidence Why is CH relevant in Glaucoma?

(Low) CH has been consistently shown to be independently and strongly associated with or predictive of glaucoma progression

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### Corneal Hysteresis in Glaucoma

Association with Progression in a Retrospective Study

	CH	IOP	CCT	P-value
Age per year <65	1.12	1.01	1.24	.03
Age per year ≥65	1.08	1.01	1.15	.02
GAT IOP per mmHg	1.22	0.95	1.58	.12
Treatment	1847.6	3.16	10 <sup>6</sup>	.02
IOP by treatment interaction	0.79	0.61	1.03	.08
CCT per 100 microns	1.65	0.66	0.98	.30
Years with glaucoma	1.00	0.96	1.04	.98
Baseline IOP	0.99	0.93	1.06	.79
CH per mmHg	0.81	0.66	0.98	.03

Conclusions: Corneal Hysteresis was the parameter most associated with progressive field worsening

Compton NJ et al. Am J Ophthalmol 2016;161:888-895

- 230 POAG or suspected POAG patients were included in the study
- 3 years or more FU
- Minimum 5 VF exams

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Ophthalmology. 2013 Aug 120(8):1533-40. doi: 10.1016/j.ophtha.2013.01.032. Epub 2013 May 1

### Corneal hysteresis as a risk factor for glaucoma progression: a prospective longitudinal study.

Medeiros FA\*, Mina-Farfan D, Liebman R, Kwan R, Zangwill LM, Weinreb RN

**Author Information**

**Abstract**

**PURPOSE:** To evaluate the role of corneal hysteresis (CH) as a risk factor for the rate of visual field progression in a cohort of patients with glaucoma followed prospectively over time.

**DESIGN:** Prospective observational cohort study.

**PARTICIPANTS:** The study group included 114 eyes of 68 patients with glaucoma followed for an average of 4.0 ± 1.1 years. Visual fields were obtained with standard automated perimetry. Included eyes had a median number of 7 (range, 5-12) tests during follow-up.

**METHODS:** The CH measurements were acquired at baseline using the Occluder Response Analyzer (Reichert Instruments, Depew, NY). Evaluation of rates of visual field change during follow-up was performed using the visual field index (VFI). Linear mixed models were used to investigate the relationship between rates of visual field loss and baseline CH, baseline intraocular pressure (IOP), and central corneal thickness (CCT), while adjusting for potentially confounding factors. An interaction term between IOP and CH was included in the model to investigate whether the effect of IOP on rates of progression depended on the level of CH.

**MAIN OUTCOME MEASURES:** Effects of CH, IOP, and CCT on rates of VFI loss over time.

**RESULTS:** The CH had a significant effect on rates of visual field progression over time. In the univariable model including only CH as a predictive factor along with time and their interaction, each 1 mmHg lower CH was associated with a 0.25%/year faster rate of VFI decline over time (P<0.001). The multivariable model showed that the effect of IOP on rates of progression depended on CH. Eyes with high IOP and low CH were at increased risk for having fast rates of disease progression. The CH explained a larger proportion of the variation in slopes of VFI change than CCT (17.4% vs. 5.2%, respectively).

**CONCLUSIONS:** The CH measurements were significantly associated with risk of glaucoma progression. Eyes with lower CH had faster rates of visual field loss than those with higher CH. The prospective longitudinal design of this study supports the role of CH as an important factor to be considered in the assessment of the risk of progression in patients with glaucoma.

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### CH as a Predictor of Progression

114 POAG eyes followed at 6 month intervals for 4 years.

CH was 2x more predictive of VF progression than GAT and 3X more predictive than CCT

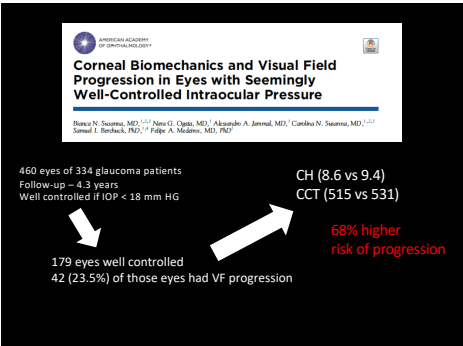
The prospective longitudinal design of this study supports the role of CH as an important factor to be considered in the assessment of risk for glaucoma progression

Medeiros FA et al. Ophthalmology. 2013;120:1533-1540.

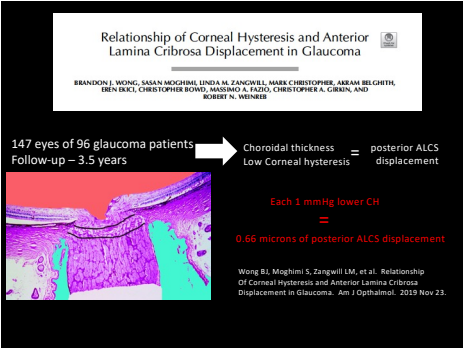
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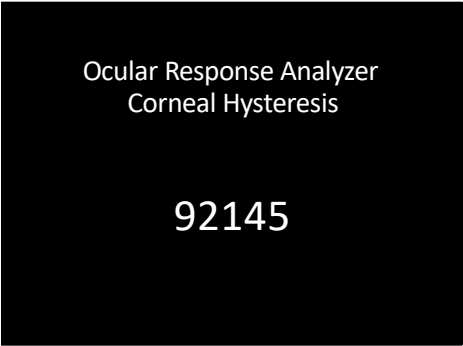




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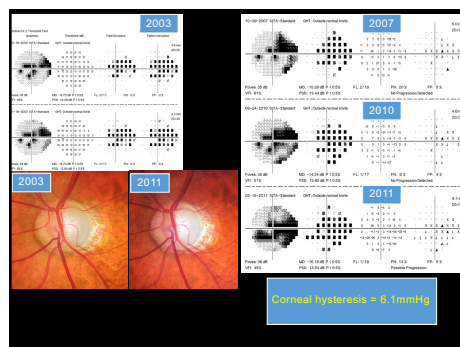
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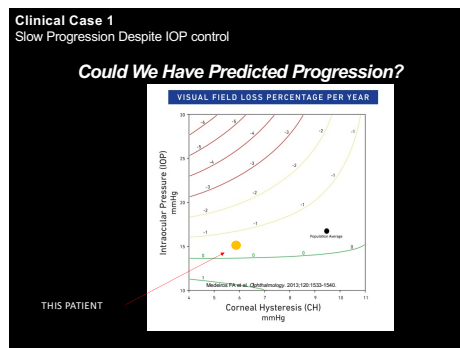
### Slow Progression Despite IOP control

Currently on maximum tolerated medical therapy and having undergone 2 sessions of laser trabeculoplasty

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**Clinical Case 2**  
High IOP "non-responder" with High CH

73 y/o Caucasian Female, diagnosed with OHTN 3 weeks prior by outside provider

Sister also being followed for glaucoma but not being treated

Meds: Bystolic, Pravastatin, MVI

Ocular Meds: Latanaprost qhs

Tmax: 26 mmHg OU

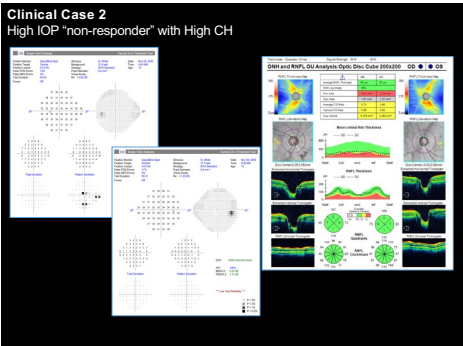
Medicated IOP: 21 mmHg ou on multiple visits

CCT: 558 OD 562 OS

CH: 11.6 OD 12.3 OS

Healthy RNFL, C/D 0.65 OD 0.6 OS, no disc heme or beta zone atrophy

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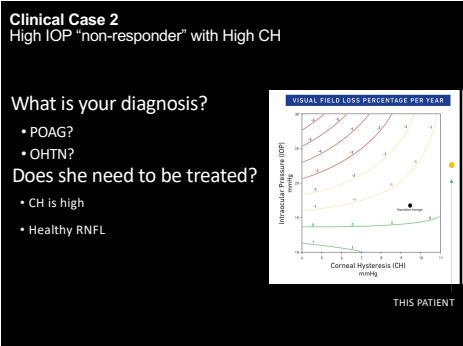
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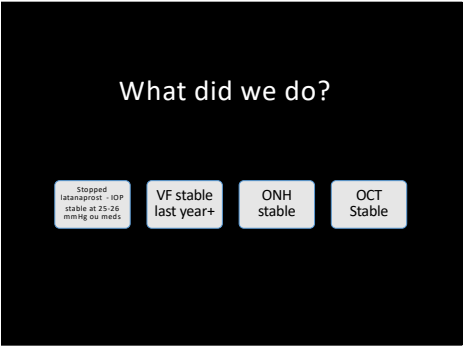
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Case 3: Patient CT (65 YO Caucasian male)

CC: Glaucoma Followup  
PmHx: Hyperlipidemia  
FhHx: Unremarkable  
Medications: Lipitor  
Topical Medications: latanoprost 0.005% qhs OU

Tmax IOP: 28 mmHg OU  
Current IOP: 22 mm HG OD, 23 mm HG OS  
Corneal Hysteresis: 10.1 OD, 11.3 OS  
Pach: 545 OU  
Gonioscopy: Open to CB, no pigment present in TM  
SLE: Unremarkable, except for well centered IOL's

ONH: C/D OD: 0.70/0.70    C/D OS: 0.75/0.75

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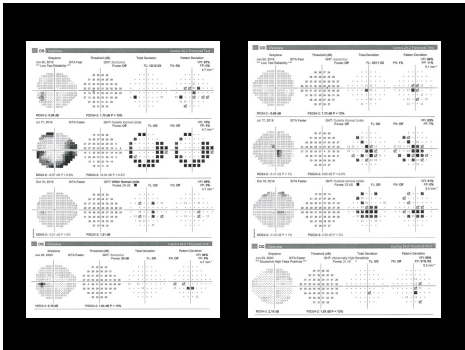
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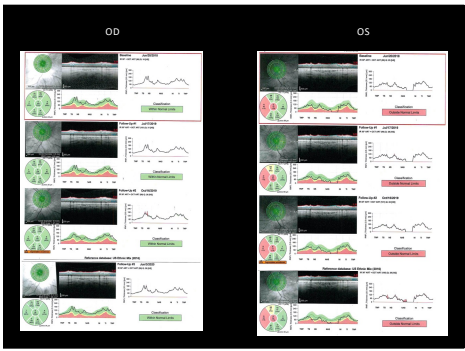
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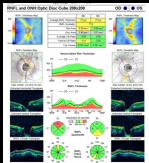
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### Would you treat SK?

Case Data:

- Age: 70 year old man presents
- IOPs (GAT): 28 mmHg OU
- CCT: 545 microns
- VF: Full (PSD 1.4)
- OCT: borderline, some thinning
- VCDR: 0.7
- Corneal Hysteresis: not available



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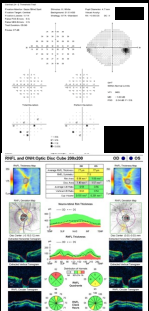
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### SK progress: 5 years later...

- Been on 3 topical agents (PGA, b-blocker and CAI)
- IOP (GAT): still 24 mmHg!
- VF: No progression in 5 years
- Old Plan: Consider Surgery
- However... (see next slide)



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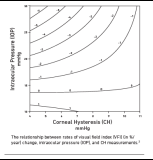
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### SK progress: 5 years later...

**CH = 13 mmHg**

New Treatment Plan:  
Continue medical therapy with ongoing monitoring of HVP and OCT



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## Summary & Considerations of SK Case

### SUMMARY

- High risk OHTN, IOP: 28 mmHg
- CCT average: 545 microns
- Patient's IOP not much lower with treatment
- No progression in 5 years
- High Corneal Hysteresis may have predicted this

### CONSIDERATIONS

What might have been done differently if Corneal Hysteresis was known 5 years ago?

How might knowing Corneal Hysteresis today change management going forward?

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## Thank You!



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