How Corneal Hysteresis Aids in Glaucoma Management

An overview of the technology and its clinical applications, including case study examples

By **Davinder S. Grover, MD, MPH**

Several years ago, I incorporated corneal hysteresis (CH) into my clinical practice and have never looked back. On a daily basis, I depend on this value to help risk stratify my glaucoma patients and further tailor their treatment needs.

Corneal hysteresis refers to the specific output number by the Ocular Response Analyzer (ORA, Reichert). Interestingly — and very clinically useful — is the output from this machine, which, in addition to a CH measurement, also reveals a predicted Goldmann applanation value (the value that the machine predicts one's Goldman applanation will read) as well as a corneal compensated IOP (IOPcc), which is a Goldmann-correlated IOP measurement that is calculated using a patented algorithm intended to minimize the influence of corneal properties. Although I personally don't put much weight in the ORA Goldmann applanation value, I feel the CH value and the IOPcc are essential when caring for patients with or at risk for glaucoma.

Here, I discuss what CH is and what it tells us about the eye and glaucoma risk, as well as provide clinical examples highlighting how CH and IOPcc values have allowed me to optimize the quality of glaucoma clinical care.

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WHAT IS CORNEAL HYSTERESIS?

Corneal hysteresis is an in-vivo measurement of the corneal and ocular biomechanics of the eye. Its value reflects the ability of the corneal tissue to dissipate energy.[1,2] The exact method for measuring CH is beyond the scope of this article; however, several peer-reviewed articles address this.[1-4] Corneal hysteresis reflects how an eye responds to stress (elevated IOP), and determines whether it absorbs the brunt of the stress or is able to dissipate the energy and somehow protect the eye and the optic nerve from the stress. Simply put, CH reflects an eye's shock-absorbing ability. Eyes that are good shock absorbers (high CH), are less likely to develop glaucoma and less likely to experience progression of glaucoma. Conversely, eyes that are poor shock absorbers (low CH) are more likely to develop glaucoma and more likely to experience progression. The CH population average for most ethnicities is around 10.[2-4]

In a well-designed prospective clinical trial, Medeiros and colleagues demonstrated that baseline CH has a significant effect on the rate of visual field progression over time.[4] Specifically, his group found that over time, eyes with a CH more than 10 did not have any rapidly progressive visual field loss; however, in the eyes with a CH less than 10, there were several cases of rapid progression, all else being equal. This study also revealed that for eyes with lower CH (<10), the impact of IOP was significantly larger than in eyes with higher CH. In fact, in their multivariate model, CH was more than three times more commonly associated with an increased rate of visual field

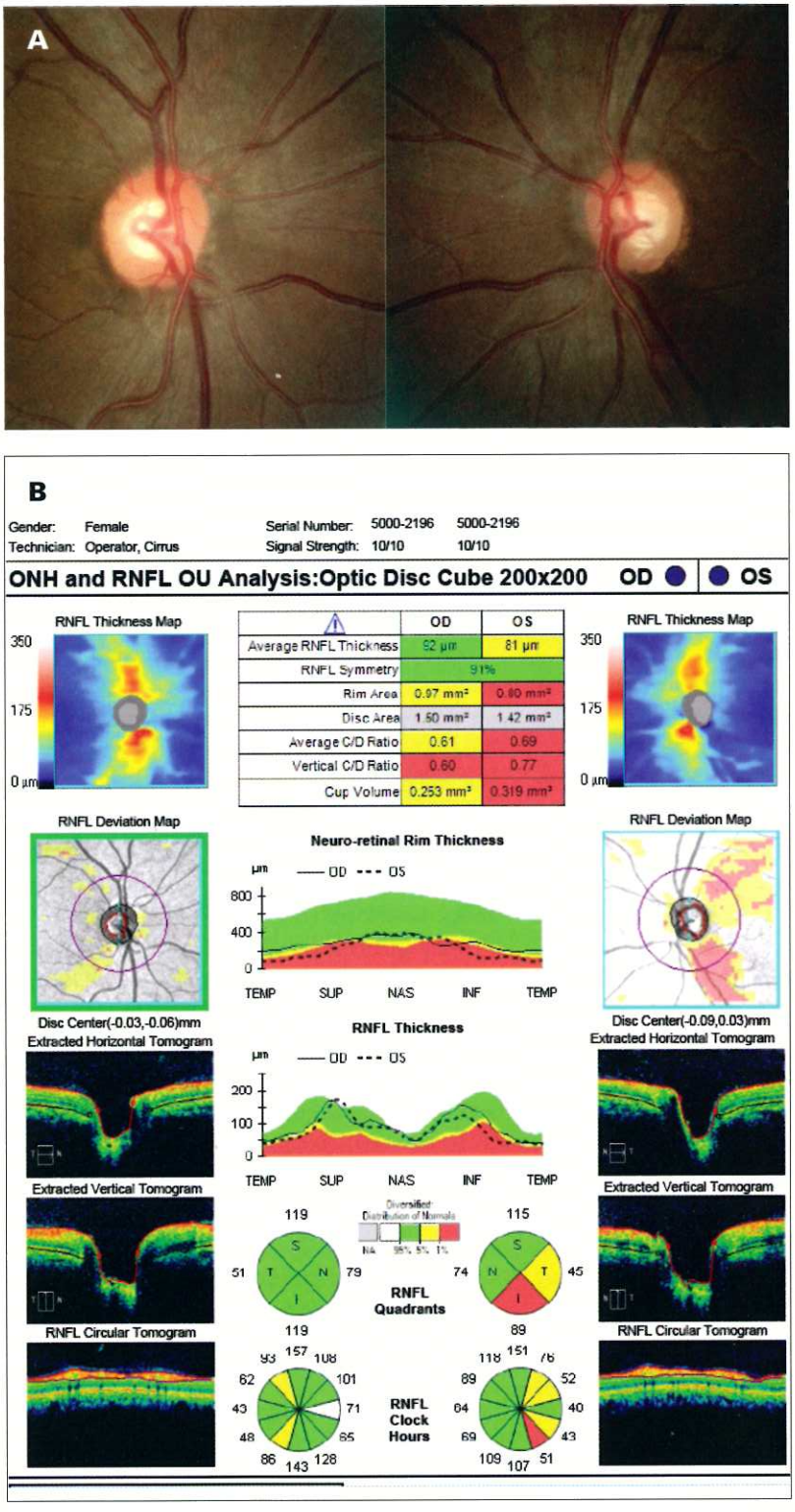

Figure 1. A 34-year-old female of Indian descent with no significant past medical or ocular history presents for glaucoma evaluation. She has a normal MRI of the brain and orbits. Over the past 9 years, she developed a progressive central scotoma OS with a corresponding wedge defect on the nerve fiber later. Figure 1A demonstrates the disc photos. Figure 1B demonstrates the baseline OCT data upon presentation.

progression than central corneal thickness. Numerous other studies have also reported similar findings.[3,5,6] Murphy and colleagues not only demonstrated that low CH is a risk factor, but that high CH is protective against glaucoma progression.[5]

CASE #1: PATIENT WITH APPARENT CONTROLLED IOP, BUT STILL PROGRESSING

A 34-year-old female of Indian descent with no significant past medical history, normal blood pressure, and a normal MRI of the brain and orbits presents with slow, progressive visual field loss in her left eye over the past 9 years. She has a classic inferior notch and wedge defect on disc exam, as well as focal loss in the nerve fiber layer on OCT (Figure 1).

Upon presentation, the patient's visual acuity was 20/20 OU and her Goldmann applanations were 10 mmHg OU with no glaucoma medications. Her initial CHand IOPcc values were 9.7 and 15.0 mmHg OD and 8.7 and 16.7 mmHg OS, respectively. Her central corneal thickness was around 500 microns OU. Given the classic glaucomatous nature of her exam and testing (and normal imaging), I started the patient on an alpha-agonist OS twice daily. She returned in 1 month. Her Goldmann applanations were essentially unchanged OU (10 mmHg); however, her IOPcc decreased from 16.7 mmHg to 11.4 mmHg OS and remained unchanged in the unmedicated eye.

Based on these results, CH predicted her left eye would be at high risk for progression, given that it has a relatively low CH compared with a near average CH OD. Additionally, this case demonstrated that in certain patients, IOPcc might be a better measure for actual IOP than Goldman applanation. What I found most surprising about this case is that the IOP decreased by more than 5 mmHg, according to the ORA machine, while my Goldman applanation did not detect a noticeable change.

CASE #2: PATIENT WITH RELATIVELY LOW IOP BUT NEW ONSET DISC HEMORRHAGE

A 59-year-old Hispanic male was referred to my practice with a new onset disc hemorrhage in his right eye. He had no significant medical or ocular history and no history of trauma. His vision was 20/20 in both eyes, and his central corneal thickness (CCT) was 536 OD and 538 OS. His Goldman applanation was 13 mmHg OD and 14mmHg OS. Interestingly, his CH was 8.7 OD and 8.9 OS. His IOPcc was 16.7mmHg OD and 17.7mmHg OS.

The IOPcc was dramatically different than his Goldmann applanation pressures, and I felt more accurately represented the patient's true clinical scenario. Also, this case demonstrates that CCT is not a surrogate for CH, a point that has been well studied and reported.[3-5]

I started the patient on a prostaglandin analogue OU and while his Goldman applanation did not change, his IOPcc decreased to 12.2 mmHg OD and 12.6 mmHg OS. Since initiating treatment, I have not detected a disc heme and now use ORA on this patient to monitor his IOP at every visit.

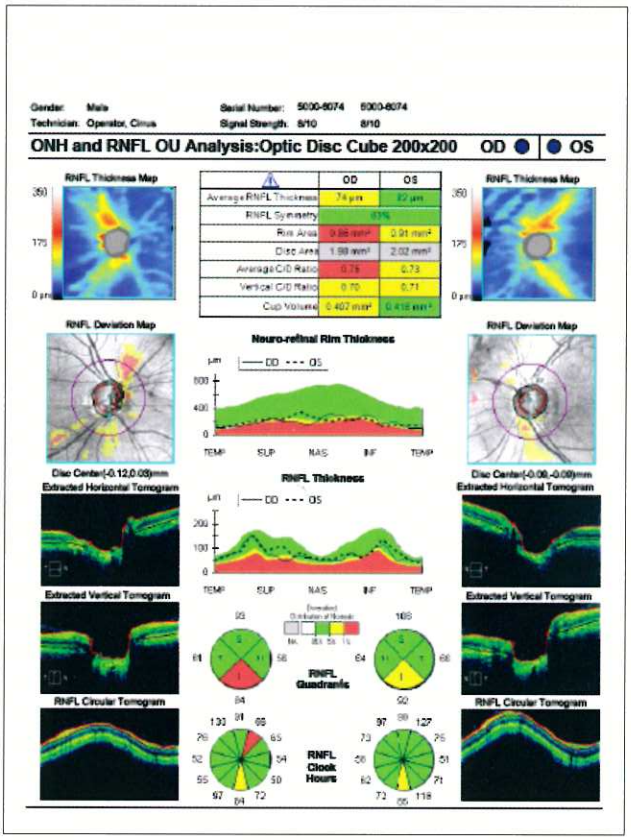

Figure 2. Case presentation of a 59-year-old Hispanic male who presented with a new onset disc hemorrhage. Baseline OCT, demonstrating focal nerve loss inferiorly OD over the region of the disc hemorrhage.

TABLE 1. HYSTERESIS

Exam Date	OD IOPcc	OS IOPcc	OD CH	OS CH	OD IOPg	OS IOPg	OD WS	OS WS
08/01/2016	12.2	12.6	9.20	9.0	9.6	9.7	7.6	7.8
06/01/2016	16.7	17.7	8.7	8.9	14.3	15.6	7.8	9.7

TABLE 2. IOP

Visit Date	Method	OD	OS
08/01/2016	Applanation	13	12
06/01/2016	Applanation	13	14

Table 1. Output data from the ORA machine demonstrating baseline values and values 2 months afterward, while started on a prostaglandin analogue.

Table 2. Output data from Goldman applanation from baseline and follow up visit. There is no apparent difference in IOP despite starting an IOP-lowering medication.

CODING FOR CORNEAL HYSTERESIS

Since January 1, 2015, CPT 92145 should be used to report this test: 92145 - Corneal hysteresis determination, by air impulse stimulation, unilateral or bilateral, with interpretation and report.

- **MEDICARE REIMBURSEMENT:** CPT 92145 is defined as "unilateral or bilateral," so reimbursement is per patient — not per eye. The 2017 national Medicare Physician Fee Schedule allows a $18 reimbursement, which includes $8 for the technical component and $10 for the professional component (i.e., interpretation). The amounts are adjusted in each area and other payers set their own rates, which may differ significantly from the Medicare published fee schedule.
- **COVERAGE:** Corneal hysteresis (CH) testing is not always covered by Medicare and other third-party payers. Some have published policies that declare CH is "experimental and investigational" and, therefore, not covered.[1,2] If coverage is unlikely, explain why the test is necessary and have the patient assume financial responsibility. A financial waiver can take several forms, such as an Advance Beneficiary Notice of Noncoverage (ABN) or a Notice of Exclusion from Health Plan Benefits (NEHB) depending on the payer.
- **FREQUENCY:** There are no published limitations for repeated testing. In general, this and all diagnostic tests are reimbursed when medically indicated. Clear documentation of the reason for testing is always required; however, steer clear of "too-frequent" testing, which can garner unwanted attention from payers.
- **SUPERVISION:** Under Medicare program standards, this test requires only "general supervision," meaning that it is done under a physician's overall direction, but a physician's presence is not required during the procedure.
- **DOCUMENTATION:** In addition to the results of the test, the medical record should contain the following: patient's name and date of test; order for the test with medical rationale; reliability of the test; test findings, such as a printout; assessment and diagnosis; comparison with prior tests (if any); impact on treatment and prognosis; and the physician's signature and date.
- **BUNDLING:** According to Medicare's National Correct Coding Initiative (NCCI), 92145 is bundled with the CPT code 92140, E/M code 99211, and HCPCS codes G0117 and G0118.

- Kevin J. Corcoran, COE, CPC, CPMA, FNAO,
president and co-owner of Corcoran Consulting Group

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A KEY VALUE

Several studies have demonstrated that CH is an independent risk factor for glaucoma progression. The evidence suggests that CH is reflective of overall ocular tissue properties and provides insight into the biomechanical principles of the eye. Moreover, CH appears to be related to pressure-independent mechanisms involved in glaucoma pathogenesis and associated changes to the optic nerve. Lastly, the IOPcc has been found to be extremely useful in patients with progressive glaucoma despite relatively low IOP readings on Goldman applanation. IOPcc may eventually be found to be more reliable and accurate than Goldmann applanation however, this has not yet been proven. In conclusion, CH is essential in my glaucoma practice, and helps me improve the quality of glaucoma care by providing better risk stratification and allowing for a more personalized treatment approach. **GP**

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