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Research Article

A Prospective Trial Determining the Relationship between Corneal Hysteresis, Corneal Corrected Intraocular Pressure, and Optical Coherence Tomography Parameters in Open Angle Glaucoma Suspects

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Abstract

Background: Glaucoma has been associated with low corneal hysteresis, a characteristic that may provide additional information in identifying those who are considered glaucoma suspects. The current study aimed to determine the relationship between corneal hysteresis, corneal compensated intraocular pressure, and GCC analysis in patients who are labeled clinically as open angle glaucoma suspects.

Methods: Participants were categorized into 2 groups, control (n = 14)

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or suspect (n = 27), based on clinical examination. Corneal hysteresis and optical coherence tomography were performed and analyzed for any correlation between these two groups.

Results: Correlations between corneal hysteresis and parapapillary retinal nerve fiber layer thickness or corneal hysteresis and ganglion cell complex thickness in the macula were weak to moderate and ranged from r = -0.340 to r = 0.316. The correlations between corneal compensated intraocular pressure and parapapillary retinal nerve fiber layer thickness or corneal compensated intraocular pressure and ganglion cell complex thickness were also weak to moderate and ranged from r = -0.489 to r = 0.396.

Conclusion: In the current study, corneal hysteresis and corneal compensated intraocular pressure did not provide a definitive relationship when trying to identify patients as glaucoma suspects. The relationships between corneal hysteresis and retinal nerve fiber layer thickness or corneal hysteresis and ganglion cell complex thickness were weak to moderate. The weak to moderate correlation was consistent even when considering retinal nerve fiber layer and ganglion cell complex global indices as well as the individual clock hours for both measurements.

Keywords: Corneal compensated intraocular pressure; Corneal hysteresis; Open angle glaucoma suspect

Introduction

Corneal hysteresis is a corneal biomechanical property that is related to the viscoelasticity of the cornea. Viscoelasticity is a somewhat complicated physical principle that describes how something that absorbs energy maintains its characteristics by acting both as an elastic system and dampener, converting some energy to heat. The corneal hysteresis and its role in glaucoma and other ocular pathology, such as Keratoconus and Fuch's Dystrophy, has been explored in great detail of late thanks to the Ocular Response Analyzer (ORA, [Reichert Inc, Buffalo, NY]) [1-3].

The ocular response analyzer is a non-contact tonometer that measures corneal biomechanical properties and intraocular pressure. In addition to measuring corneal hysteresis and the Goldmann-correlated intraocular pressure, the ocular response analyzer also measures the corneal compensated intraocular pressure. Corneal compensated intraocular pressure is of special interest because unlike Goldman applanation tonometry; it has been found to be non-dependent on central corneal thickness [4,5]. The corneal compensated intraocular pressure correlates well with Goldman applanation tonometry in healthy eyes; however, glaucomatous eyes have been shown to have a higher corneal compensated intraocular pressure when compared to Goldman applanation tonometry [6]. This difference is most pronounced in normal tension glaucoma patients where the disparity between corneal compensated intraocular pressure and Goldman applanation tonometry can be up to 5 mmHg [6].

Spectral Domain Optical Coherence Tomography (OCT, Cirrus HD-OCT [Carl Zeiss Meditec, Dublin, CA]) obtains 3-D data cubes of the optic disc and macula for quantitative assessment to include

parapapillary Retinal Nerve Fiber Layer (RNFL) thickness and the Ganglion Cell Complex thickness (GCC) [7]. The ganglion cells within the inner retina contain axons that comprise the RNFL. RNFL loss is a well-recognized sign of early glaucoma. Recently, imaging of the layer containing the ganglion cell bodies and their dendrites has become commercially available. GCC imaging is a promising technology since damage to the ganglion cells should theoretically precede the loss of the retinal nerve fiber layer [7].

A challenging aspect of patient care in glaucoma is arriving at the diagnosis of glaucoma from glaucoma suspect. While the diagnosis may be clear at times, it frequently is not. With suspicious characteristics or findings still present, patients are often labeled glaucoma suspects. Technology such as spectral domain optical coherence tomography has improved the diagnostic accuracy, but additional confirmatory testing would be helpful in making this difficult determination. The purpose of this investigation is to determine the relationship between corneal hysteresis, corneal compensated intraocular pressure, and GCC analysis in patients who are labeled clinically as open angle glaucoma suspects versus a control group.

Methods

Clinical definition of glaucoma suspect has been described elsewhere [8] and includes: Goldman applanation tonometry of greater than or equal to 22 mmHg, and/or cup to disk ratio of greater than or equal to 0.5 with the appearance of glaucomatous optic nerve damage (i.e., thinning or notching), and/or a cup to disc asymmetry of greater than or equal to 0.2. For complete inclusion/exclusion criteria (Table 1).

Consecutive patients that presented for an eye examination were asked to participate in the study. If both eyes of a normal patient were eligible, both eyes were included in the study. Consecutive patients who presented for an eye exam and were determined to be a glaucoma suspect or have been determined to be a glaucoma suspect on a previ

ous visit were asked to participate in the study. All patients signed an informed consent in accordance with the Declaration of Helsinki; the Schulman Institutional Review board approved the study.

Willing patients underwent a baseline examination. This included best corrected visual acuity, a detailed ocular, family, and medical history, blood pressure, pulse, pupil and extra-ocular muscle testing, Goldmann intraocular pressure (average of 2 measurements), slit lamp exam, gonioscopy, corneal pachymetry, Ocular Response Analyzer testing (average of 2 measurements), dilated fundus exam, spectral domain optical coherence tomography testing of both retinal nerve fiber layer and ganglion cell complex, and 24-2 Humphrey SITA standard visual field testing. The study used the reference database on the Cirrus 5.0 optical coherence tomography to define thinning of the retinal nerve fiber layer and the ganglion cell complex. Optical coherence tomography testing was repeated to confirm defects. Only signal strength of 8 or greater on optical coherence tomography testing and 6.5 or greater on Ocular Response Analyzer testing was accepted. Visual field tests included in the study had less than 33 % false positive, false negative results, and fixation loss and the reference database on the Humphrey visual field was used to determine normal versus abnormal values. Any visual field depression was repeated 2-4 weeks later to confirm its reproducibility. If a visual field abnormality was confirmed the patient was excluded from the study and treatment was initiated appropriately.

The optic nerve head parameters were confirmed with optical coherence tomography testing to reduce intra- and inter- observer variability. The eye that met the criteria to be considered a glaucoma suspect was used in the study; if both eyes met the criteria, then both eyes were used in the study. However, if either eye in a patient is deemed to be a glaucoma suspect the other eye was not used as a normal control. Inclusion/Exclusion criteria are included in table 1. Specifically, patients with mixed mechanism glaucoma, previous ocular surgery, and coexisting ocular pathology were excluded from the study.

Control	Glaucoma Suspect Inclusion	Exclusion
Goldmann IOP between 11-21 mmHg	Goldmann IOP >/= 22mmHg	BCVA worse than 6/12 in either eye
CD </= 0.4	CD ratio >/= 0.5 with glaucomatous nerve damage	Hx of angle closure/recession or occludable angle on gonioscopy
CD asymmetry < 0.2	CD asymmetry >/= 0.2	PXF/PDS in either eye
No first degree FxHx of Glaucoma	Open angle on Gonioscopy	Previous SLT/ALT/LPI in either eye
	Age [25-82]	Any previous treatment with topical/oral glaucoma medication
	Pachymetry [500-650 um]	Previous ocular surgery including refractive, cataract, and glaucoma
	Ability to speak, read and understand English	Currently active uveitis, Hx of uveitis
		Corneal dystrophy, ulcer or infection
		Hx of overnight contact lens wear
		Visual field loss (regardless of etiology)
		Macular/Retinal pathology
		Optic nerve head drusen
		Systemic medication with IOP effects (corticosteroids, carbonic anhydrase inhibitors, etc)
		Women who are or intend to become pregnant in next 4 months (patient reported)

Table 1: Inclusion/Exclusion.

IOP- Intraocular Pressure; CD- Cup-to-Disc; FxHx- Family History; BCVA- Best Corrected Visual Acuity; PXF- Pseudo Exfoliation Syndrome; PDS- Pigment Dispersion Syndrome; SLT- Selective Laser Trabeculoplasty; ALT- Argon Laser Trabeculoplasty; LPI- Laser Peripheral Iridotomy; Macular Pathology defined as but not limited to Diabetic retinopathy, Age related macular degeneration, Vitreomacular traction, Macular hole, Epiretinal membrane

Statistical Analysis

All collected data was analyzed computing a combination of descriptive statistics and correlation coefficients using SPSS v24. The achieved power was 0.93 (1-β error probability) given α of 0.05 and a sample size of 70. For all analyses, the nasal and temporal quadrants were correlated between the right and left eye and all clock hours are referenced to the right eye in order to aid in interpretation. The statistical methods used in this study included frequency distributions, means, standards deviations, and Pearson correlation coefficients.

Results

The study enrolled a total of 70 eyes (27 control and 43 glaucoma suspect). Gender distribution was similar between the two groups, however, the age and racial distributions of the two groups were uneven (Table 2). The average age of patients in the control group was 37 years old (SD 14.39) and the average age in the glaucoma suspect group was 59 years old (SD 13.31). While the control group was overwhelmingly Caucasian (71 percent), the second group was mixed between Caucasian and African American with some other races as well.

	Control	Glaucoma Suspect
Number of Unduplicated Participants	14	27
Average Age (SD)	37.00 (14.39)	59.37 (13.31)
Gender		
Male	35.7 %	33.3 %
Female	64.3 %	66.7 %
Race		
Caucasian	71.4 %	59.3 %
African American	21.4	33.3
Hispanic	7.2	3.7
Asian	0.0	3.7

Table 2: Unduplicated participant demographics.

Based on the data obtained, the relationships were weak to moderate between corneal hysteresis and RNFL or corneal hysteresis and GCC in the suspect and control groups, with correlations ranging from $r = -0.340$ to $r = 0.316$ (Table 3). The weak to moderate correlation were found when considering RNFL and GCC global indices as well as the individual clock hours for both RNFL and GCC.

The relationships were mixed between corneal compensated intraocular pressure and RNFL or corneal compensated intraocular pressure and GCC in the suspect and control groups, with correlations ranging from $r = -0.489$ to $r = 0.396$ (Table 4). The corneal compensated intraocular pressure correlation to individual RNFL clock hours found trends that were of interest. Specifically, RNFL clock hour 12 provided a weak negative correlation for the suspect group ($r = -0.259$) compared to a stronger positive moderate correlation in the control group ($r = 0.329$). Similarly, RNFL clock hour 1 o'clock provided a weak negative correlation for the suspect group ($r = -0.245$) compared to a stronger positive moderate correlation in the control group ($r = 0.396$, $\rho = 0.041$). Something that surprised the authors was that while the suspect group had a weak negative correlation at RNFL clock hour 9 o'clock ($r = -0.183$), the control group had a moderately strong negative correlation ($r = -0.489$, $\rho = 0.010$) at the same position.

Similar analysis was performed with Goldmann applanation tonometry vs RNFL thickness, with correlations ranging from $r = -0.393$ to $r = 0.316$ (Table 5). The overall thickness showed a moderate negative correlation in the suspect group ($r = -0.343$, $\rho = 0.025$), with a stronger negative correlations at RNFL clock hour 5 o'clock and 6 o'clock ($r = -0.390$, $\rho = 0.008$; and $r = -0.393$, $\rho = 0.008$ respectively). However, the rest of the hourly comparisons of the RNFL thickness vs. Goldmann applanation tonometry were not consistent and did not match the corneal compensated intraocular pressure correlation.

Discussion

Identifying glaucomatous risk factors early in the life of a patient is important, not only for those who require treatment and regular follow ups, but to help lessen repetitive testing in those that may not share the same anatomical characteristics as others. Corneal hysteresis has provided another metric that can quantify the biomechanical properties within a cornea and its relationship with other anatomical/physiological variations. The role of optical coherence tomography and early glaucoma detection are well established; both retinal nerve fiber layer thickness and ganglion cell complex play a vital role in monitoring irreversible damage caused by glaucoma. The purpose of this investigation was to determine the relationship between corneal hysteresis/corneal compensated intraocular pressure and current optical coherence tomography technology in patients labeled clinically as open angle glaucoma suspects.

Given the relationship between corneal hysteresis and corneal compensated intraocular pressure to glaucoma [9,10] the authors were surprised to find that corneal hysteresis did not appear to have any strong relationship with glaucoma suspects in regards to the RNFL and GCC measurements when compared to the control group. While corneal compensated intraocular pressure correlations in certain RNFL clock hours reached statistical significance, these were weak to moderate correlations and were not consistent throughout the analysis. These inconsistent results may be explained by limitations of current corneal hysteresis and OCT technologies, such measurement variability, segmentation algorithms, and/or potential study bias from utilizing both eyes of study patients. Due to the weak to only moderate correlations found in the current study, it appeared that corneal hysteresis and corneal compensated intraocular pressure did not provide a definitive relationship when trying to identify patients as glaucoma suspects. There may be merit in evaluating the same group over time, or patients already diagnosed with glaucoma, and examining biomechanics trends in those who progress compared to those who do not.

Limitations of the current study include its small sample size, uneven patient demographics, and limited progression analysis. The authors suggest that the results of the current study be confirmed with a larger multicenter prospective trial that includes a more diverse patient population. Despite the best efforts to quantify glaucoma suspects, certain criteria are inevitably subjective and cloud any statistical analysis. This highlights both the difficulty in studying and need for more definitive measures in labeling those as glaucoma suspects.

Acknowledgement

	Mean (SD)	Correlation with Baseline Corneal Hysteresis - SUSPECT GROUP (Sig.)	Mean (SD)	Correlation with Baseline Corneal Hysteresis - CONTROL GROUP (Sig.)
Number of Eyes		43		27
Corneal Hysteresis	12.58 (11.74)		11.54 (1.57)	
Baseline OCT average RNFL	93.76 (20.00)	$r = 0.032$ ($\rho = 0.837$)	93.50 (10.99)	$r = -0.040$ ($\rho = 0.841$)
Baseline 12 o'clock RNFL	113.69 (30.00)	$r = 0.148$ ($\rho = 0.331$)	109.00 (29.85)	$r = -0.118$ ($\rho = 0.556$)
Baseline 1 o'clock RNFL	99.51 (22.39)	$r = 0.065$ ($\rho = 0.670$)	101.19 (24.66)	$r = -0.177$ ($\rho = 0.377$)
Baseline 2 o'clock RNFL	88.60 (17.92)	$r = 0.106$ ($\rho = 0.487$)	86.70 (18.66)	$r = 0.251$ ($\rho = 0.207$)
Baseline 3 o'clock RNFL	62.49 (10.20)	$r = -0.090$ ($\rho = 0.557$)	56.15 (9.97)	$r = 0.172$ ($\rho = 0.390$)
Baseline 4 o'clock RNFL	66.69 (14.22)	$r = 0.055$ ($\rho = 0.718$)	65.44 (9.52)	$r = 0.064$ ($\rho = 0.749$)
Baseline 5 o'clock RNFL	91.47 (20.67)	$r = 0.023$ ($\rho = 0.883$)	101.37 (23.85)	$r = 0.109$ ($\rho = 0.588$)
Baseline 6 o'clock RNFL	121.64 (31.68)	$r = -0.038$ ($\rho = 0.802$)	136.48 (36.82)	$r = 0.028$ ($\rho = 0.889$)
Baseline 7 o'clock RNFL	127.78 (24.51)	$r = 0.115$ ($\rho = 0.452$)	133.81 (23.87)	$r = -0.340$ ($\rho = 0.083$)
Baseline 8 o'clock RNFL	67.13 (20.14)	$r = 0.181$ ($\rho = 0.233$)	68.74 (14.37)	$r = -0.083$ ($\rho = 0.682$)
Baseline 9 o'clock RNFL	51.07 (10.45)	$r = -0.238$ ($\rho = 0.115$)	54.93 (17.23)	$r = 0.069$ ($\rho = 0.733$)
Baseline 10 o'clock RNFL	78.11 (19.01)	$r = 0.014$ ($\rho = 0.928$)	83.07 (24.56)	$r = -0.053$ ($\rho = 0.793$)
Baseline 11 o'clock RNFL	124.60 (23.83)	$r = 0.068$ ($\rho = 0.656$)	125.56 (25.32)	$r = 0.047$ ($\rho = 0.815$)
Baseline GCC average	78.47 (8.89)	$r = 0.231$ ($\rho = 0.128$)	81.20 (12.32)	$r = 0.260$ ($\rho = 0.209$)
Baseline GCC minimum	75.73 (10.00)	$r = 0.155$ ($\rho = 0.308$)	80.08 (13.35)	$r = 0.164$ ($\rho = 0.433$)
Baseline Sup GCC	79.00 (9.03)	$r = 0.244$ ($\rho = 0.107$)	81.20 (13.17)	$r = 0.272$ ($\rho = 0.188$)
Baseline Sup temp GCC	79.20 (8.22)	$r = 0.168$ ($\rho = 0.271$)	80.32 (11.58)	$r = 0.316$ ($\rho = 0.124$)
Baseline Inf temp GCC	78.73 (8.74)	$r = 0.161$ ($\rho = 0.290$)	80.92 (10.98)	$r = 0.216$ ($\rho = 0.300$)
Baseline Inf GCC	74.69 (13.83)	$r = 0.138$ ($\rho = 0.367$)	78.96 (12.30)	$r = 0.167$ ($\rho = 0.426$)
Baseline Inf nasal GCC	78.33 (9.81)	$r = 0.215$ ($\rho = 0.156$)	82.12 (12.78)	$r = 0.281$ ($\rho = 0.174$)
Baseline Sup nasal GCC	79.49 (10.13)	$r = 0.257$ ($\rho = 0.089$)	82.52 (12.45)	$r = 0.253$ ($\rho = 0.222$)

Table 3: Correlations - Corneal hysteresis and RNFL, Corneal hysteresis and GCC.

	Mean (SD)	Correlation with Baseline corneal compensated intraocular pressure - SUSPECT GROUP (Sig.)	Mean (SD)	Correlation with Baseline corneal compensated intraocular pressure - CONTROL GROUP (Sig.)
Number of Eyes		43		27
Corneal Compensated Intraocular Pressure	18.68 (4.72)		15.08 (3.55)	
Baseline OCT average RNFL	93.76 (20.00)	$r = -0.113$ ($\rho = 0.471$)	93.50 (10.99)	$r = -0.201$ ($\rho = 0.314$)
Baseline 12 o'clock RNFL	113.69 (30.00)	$r = -0.259$ ($\rho = 0.085$)	109.00 (29.85)	$r = 0.329$ ($\rho = 0.094$)
Baseline 1 o'clock RNFL	99.51 (22.39)	$r = -0.245$ ($\rho = 0.104$)	101.19 (24.66)	$r = 0.396$ ($\rho = 0.041$)
Baseline 2 o'clock RNFL	88.60 (17.92)	$r = -0.076$ ($\rho = 0.620$)	86.70 (18.66)	$r = 0.160$ ($\rho = 0.424$)
Baseline 3 o'clock RNFL	62.49 (10.20)	$r = -0.015$ ($\rho = 0.921$)	56.15 (9.97)	$r = -0.270$ ($\rho = 0.174$)
Baseline 4 o'clock RNFL	66.69 (14.22)	$r = -0.205$ ($\rho = 0.178$)	65.44 (9.52)	$r = -0.036$ ($\rho = 0.857$)
Baseline 5 o'clock RNFL	91.47 (20.67)	$r = -0.238$ ($\rho = 0.115$)	101.37 (23.85)	$r = -0.099$ ($\rho = 0.625$)
Baseline 6 o'clock RNFL	121.64 (31.68)	$r = -0.256$ ($\rho = 0.089$)	136.48 (36.82)	$r = -0.282$ ($\rho = 0.154$)
Baseline 7 o'clock RNFL	127.78 (24.51)	$r = -0.216$ ($\rho = 0.154$)	133.81 (23.87)	$r = -0.370$ ($\rho = 0.058$)
Baseline 8 o'clock RNFL	67.13 (20.14)	$r = 0.043$ ($\rho = 0.779$)	68.74 (14.37)	$r = -0.368$ ($\rho = 0.059$)
Baseline 9 o'clock RNFL	51.07 (10.45)	$r = -0.183$ ($\rho = 0.229$)	54.93 (17.23)	$r = -0.489$ ($\rho = 0.010$)
Baseline 10 o'clock RNFL	78.11 (19.01)	$r = -0.163$ ($\rho = 0.285$)	83.07 (24.56)	$r = -0.291$ ($\rho = 0.141$)
Baseline 11 o'clock RNFL	124.60 (23.83)	$r = -0.229$ ($\rho = 0.130$)	125.56 (25.32)	$r = -0.127$ ($\rho = 0.527$)
Baseline GCC average	78.47 (8.89)	$r = -0.127$ ($\rho = 0.405$)	81.20 (12.32)	$r = -0.242$ ($\rho = 0.243$)
Baseline GCC minimum	75.73 (10.00)	$r = -0.137$ ($\rho = 0.371$)	80.08 (13.35)	$r = -0.159$ ($\rho = 0.448$)
Baseline Sup GCC	79.00 (9.03)	$r = -0.133$ ($\rho = 0.384$)	81.20 (13.17)	$r = -0.267$ ($\rho = 0.197$)
Baseline Sup temp GCC	79.20 (8.22)	$r = -0.206$ ($\rho = 0.174$)	80.32 (11.58)	$r = -0.330$ ($\rho = 0.108$)
Baseline Inf temp GCC	78.73 (8.74)	$r = -0.158$ ($\rho = 0.301$)	80.92 (10.98)	$r = -0.254$ ($\rho = 0.220$)
Baseline Inf GCC	74.69 (13.83)	$r = -0.037$ ($\rho = 0.808$)	78.96 (12.30)	$r = -0.182$ ($p = 0.384$)
Baseline Inf nasal GCC	78.33 (9.81)	$r = -0.139$ ($\rho = 0.363$)	82.12 (12.78)	$r = -0.214$ ($\rho = 0.304$)
Baseline Sup nasal GCC	79.49 (10.13)	$r = -0.084$ ($\rho = 0.585$)	82.52 (12.45)	$r = -0.233$ ($\rho = 0.262$)

Table 4: Correlations - Corneal compensated intraocular pressure and RNFL, corneal compensated intraocular pressure and GCC.

	Mean (SD)	Correlation with Baseline Goldmann Intra-ocular Pressure-SUSPECT GROUP (Sig.)	Mean (SD)	Correlation with Baseline Goldmann Intra-ocular Pressure-CONTROL GROUP (Sig.)
Number of Eyes		43		27
Goldmann intraocular pressure	18.39 (5.16)		15.63 (4.27)	
Baseline OCT average RNFL	93.76 (20.00)	$r = -0.343$ $(\rho = 0.025)$	93.50 (10.99)	$r = -0.274$ $(\rho = 0.166)$
Baseline 12 o'clock RNFL	113.69 (30.00)	$r = -0.174$ $(\rho = 0.252)$	109.00 (29.85)	$r = 0.045$ $(\rho = 0.822)$
Baseline 1 o'clock RNFL	99.51 (22.39)	$r = -0.141$ $(\rho = 0.355)$	101.19 (24.66)	$r = 0.164$ $(\rho = 0.414)$
Baseline 2 o'clock RNFL	88.60 (17.92)	$r = -0.246$ $(\rho = 0.104)$	86.70 (18.66)	$r = 0.151$ $(\rho = 0.451)$
Baseline 3 o'clock RNFL	62.49 (10.20)	$r = -0.209$ $(\rho = 0.169)$	56.15 (9.97)	$r = -0.252(\rho = 0.205)$
Baseline 4 o'clock RNFL	66.69 (14.22)	$r = -0.275$ $(\rho = 0.067)$	65.44 (9.52)	$r = -0.249$ $(\rho = 0.210)$
Baseline 5 o'clock RNFL	91.47 (20.67)	$r = -0.390$ $(\rho = 0.008)$	101.37 (23.85)	$r = -0.290$ $(\rho = 0.142)$
Baseline 6 o'clock RNFL	121.64 (31.68)	$r = -0.393$ $(\rho = 0.008)$	136.48 (36.82)	$r = -0.302$ $(\rho = 0.126)$
Baseline 7 o'clock RNFL	127.78 (24.51)	$r = -0.184$ $(\rho = 0.225)$	133.81 (23.87)	$r = -0.328$ $(\rho = .095)$
Baseline 8 o'clock RNFL	67.13 (20.14)	$r = 0.316$ $(\rho = 0.035)$	68.74 (14.37)	$r = -0.198$ $(\rho = 0.322)$
Baseline 9 o'clock RNFL	51.07 (10.45)	$r = 0.129$ $(p = 0.400)$	54.93 (17.23)	$r = -0.338$ $(\rho = 0.084)$
Baseline 10 o'clock RNFL	78.11 (19.01)	$r = -0.016$ $(\rho = 0.918)$	83.07 (24.56)	$r = -0.179$ $(\rho = 0.373)$
Baseline 11 o'clock RNFL	124.60 (23.83)	$r = -0.099$ $(\rho = .519)$	125.56 (25.32)	$r = 0.006$ $(p = 0.976)$
Baseline GCC average	78.47 (8.89)	$r = -0.145$ $(\rho = .342)$	81.20 (12.32)	$r = -0.130$ $(\rho = 0.536)$
Baseline GCC minimum	75.73 (10.00)	$r = -0.103$ $(\rho = 0.502)$	80.08 (13.35)	$r = -0.094$ $(\rho = 0.656)$
Baseline Sup GCC	79.00 (9.03)	$r = -0.123$ $(\rho = 0.422)$	81.20 (13.17)	$r = -0.126$ $(\rho = 0.549)$
Baseline Sup temp GCC	79.20 (8.22)	$r = -0.170$ $(\rho = .265)$	80.32 (11.58)	$r = -0.191$ $(\rho = 0.361)$
Baseline Inf temp GCC	78.73 (8.74)	$r = -0.140$ $(\rho = .358)$	80.92 (10.98)	$r = -0.149$ $(\rho = 0.478)$
Baseline Inf GCC	74.69 (13.83)	$r = -0.151$ $(\rho = .321)$	78.96 (12.30)	$r = -0.136$ $(\rho = 0.516)$
Baseline Inf nasal GCC	78.33 (9.81)	$r = -0.148$ $(\rho = 0.330)$	82.12 (12.78)	$r = -0.123$ $(\rho = .558)$
Baseline Sup nasal GCC	79.49 (10.13)	$r = -0.085$ $(\rho = 0.578)$	82.52 (12.45)	$r = -0.138$ $(\rho = 0.509)$

Table 5: Correlations - Goldmann intraocular pressure and RNFL, Goldmann intraocular pressure and GCA.

Conflicts of interest

Dr. Paul Karpecki's financial disclosures include consultation work for Aerie Pharmaceuticals, Akorn, Alcon Labs, Allergan, Bausch + Lomb/Valeant, Glaukos, iCare USA, Katena, Konan Medical, Ocular Therapeutix, Oculus, Optometric Medical Solutions (OMS), Paragon Bioteck, Reichert, Shire Pharmaceuticals, Science Based Health, Sentiss Pharmaceuticals, and Topcon.

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