Effects of Inadequate Anterior Segment Compensation on Measurements With Scanning Laser Polarimetry

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Abstract. The effects of poor anterior segment compensation on scanning laser polarimetry measurements of the retinal nerve fiber layer (RNFL) were systematically explored. A prototype scanning laser polarimeter with an adjustable compensator to neutralize anterior segment birefringence was used. By systematically varying the magnitude and axis of anterior segment compensation in a healthy and a glaucomatous eye, marked changes were observed in RNFL appearance: the healthy eye appeared to have glaucomatous damage, whereas the glaucomatous eye appeared to have a thicker and healthier RNFL. Even small amounts of uncompensated corneal birefringence, which may occur in routine clinical use, resulted in apparent changes in RNFL morphology. Knowledge of this effect is important for clinicians when using scanning laser polarimetry in clinical practice. [Ophthalmic Surg Lasers Imaging 2006;37:54-57.]

INTRODUCTION

Scanning laser polarimetry, featured in the GDx nerve fiber analyzer and the GDx VCC (Carl Zeiss Meditec, Jena, Germany), estimates retinal nerve fiber layer (RNFL) thickness by measuring the retardation of polarized light by the birefringent RNFL. To cancel retardation by the cornea and lens, the GDx nerve fiber analyzer is equipped with a so-called fixed corneal compensator that cancels a fixed amount of birefringence reflecting the median values in the general population (i.e., a corneal polarization magnitude [CPM] of 60 nm and a corneal polarization axis [CPA] of 15° nasally downward). However, the fixed corneal compensator incompletely neutralizes anterior segment retardation in many eyes due to large inter-eye variability of corneal birefringence, which may lead to spurious measurements. Scanning laser polarimetry with a variable corneal compensator, featured in the GDx VCC, allows eye-specific compensation, resulting in more accurate assessment of the RNFL and an increased diagnostic accuracy.

In the current report, we systematically varied the anterior segment compensation in a healthy and a glaucomatous eye to clarify the effect of residual anterior segment birefringence on measurements of RNFL retardation with scanning laser polarimetry.

CASE REPORT

We measured the right eye of a healthy subject, which had a healthy-looking optic disc, normal visual fields, and an intraocular pressure of less than 21 mm Hg, with a modified GDx nerve fiber analyzer in which the fixed corneal compensator had been replaced by a variable corneal compensator that could be adjusted manually. In addition, we measured the left eye of a patient with glaucoma, which had a glaucomatous-looking optic nerve head and corresponding visual field loss.

The axis and magnitude of anterior segment birefringence were determined by macular polarimetry images with the variable compensator set to 0 nm, as described by Zhou and Weinreb. For each eye, 49 measurements were obtained with systematically step-wise varying degrees of compensation for CPM and CPA, relative to each eye's anterior segment birefrin-
Retardation images are shown in Figures 1 and 2. With complete compensation for CPM and CPA (central images), the retardation image in the healthy subject showed a retardation pattern typical for healthy subjects, with high values (bright colors) superiorly and inferiorly around the vessels, and low values (dim colors) temporally and nasally. In the patient with glaucoma, retardation values were low, especially in the superior region.

By varying the degree of compensation for CPM and CPA, the pattern of retardation changed markedly in both subjects. Notably, the apparent positions of the arcuate bundles could be altered in the healthy subject (compare two uppermost rows of frames to two lowest in Fig. 1). In addition, the healthy eye could appear to have glaucomatous damage inferiorly (eg, when compensated for a CPM of 70 nm and a CPA of 10° nasally downward) (Fig. 1). In the patient with glaucoma,
compensation for a CPM of 55 nm and a CPA of 10° nasally downward resulted in an apparent increase in RNFL thickness (Fig. 2).

**DISCUSSION**
The two series of retardation images in this case report illustrate to what extent the apparent RNFL thickness in scanning laser polarimetry can be artificially increased or decreased as a result of incomplete compensation of anterior segment birefringence. For scanning laser polarimetry with a fixed corneal compensator, with its fixed compensation of anterior segment birefringence, such artifacts may occur in many subjects due to the large variability in corneal birefringence. When switching from scanning laser polarimetry with a fixed corneal compensator to a variable corneal compensator, with eye-specific compensation of anterior segment birefringence, changes in the pattern of the RNFL as illus-
trated in the current report will have to be expected. We think this requires setting a new baseline when monitoring glaucomatous changes of the RNFL over time.

By stepwise variation of the compensation for CPA and CPM, we showed that even small changes of ±5° in compensation for CPA resulted in distinct changes in the retardation images. Such small amounts of uncompensated corneal birefringence may occur in GDx VCC measurements with automated compensation with routine clinical use, either mimicking or masking glaucomatous progression. In fact, CPA may vary up to 13° between measurements in individual eyes. Therefore, we suggest determining an eye’s anterior segment birefringence at every visit and asking patients to keep their heads in the same position on the GDx VCC face mask between measurements of anterior segment birefringence and subsequent assessment of RNFL birefringence.

We evaluated the effect of residual anterior segment birefringence on scanning laser polarimetry measurements only qualitatively. Future studies may also quantitatively assess the effect of residual anterior segment birefringence in the individual eye. Knowledge of the extent of these effects may improve clinical use of scanning laser polarimetry in the diagnosis and monitoring of glaucoma.

REFERENCES