Comparative Study of Retinal Nerve Fiber Layer Measurement by StratusOCT and GDx VCC, I: Correlation Analysis in Glaucoma

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PURPOSE. To evaluate the average and regional correlations of retinal nerve fiber layer (RNFL) thickness measured by StratusOCT (optical coherence tomography; Carl Zeiss Meditec, Inc., Dublin, CA) and GDx VCC (Laser Diagnostic Technologies, Inc., San Diego, CA).

METHODS. Eighty-nine subjects—27 normal, 21 with suspected glaucoma, and 41 with glaucoma—were included in this cross-sectional study. The total average and the mean 12-clock-hour RNFL thickness were measured with the StratusOCT and GDx VCC. The discriminating powers of the two techniques for detection of suspected glaucoma and glaucoma were compared by the area under the receiver operating characteristic curves (AUC). Correspondence between StratusOCT and GDx VCC RNFL measurements in each clock hour was examined with linear regression analysis.

RESULTS. The average RNFL thickness in the normal group was measured at 101.38 ± 7.73 and 55.26 ± 4.32 μm by StratusOCT and GDx VCC, respectively. Both nerve fiber analyzers demonstrated a double-hump pattern in the RNFL profiles with maximum RNFL thickness located at the inferotemporal and superotemporal clock hours by the StratusOCT and the superior and inferior clock hours by the GDx VCC. Significant differences were found in the total average and the individual clock-hour RNFL thickness between StratusOCT and GDx VCC RNFL measurements in both the normal and the suspected glaucoma/glaucoma groups. The GDx VCC superior RNFL measurement demonstrated the largest AUC (0.909) for detection of suspected glaucoma and glaucoma, whereas the largest AUC (0.901) in StratusOCT was found over the inferotemporal clock hour. The total average RNFL thickness measured with StratusOCT and GDx VCC correlated highly with each other (r = 0.852). When the respective clock-hour RNFL measurements were compared, the correlation coefficient varied with the position around the optic nerve head, with the highest correlation found over the superior and inferior clock hours (11, 12, 1, 6, and 7 o’clock; all with r > 0.700) and the lowest located at the temporal clock hour (9 o’clock; r = 0.277).

CONCLUSIONS. Despite the substantial differences in the values of RNFL thickness, significant correlations were observed between StratusOCT and GDx VCC RNFL measurements. The variations of the correlation coefficient around the optic nerve head suggested that GDx VCC RNFL measurement does not have a fixed relationship with that of StratusOCT and the use of site-specific RNFL birefringences may improve the estimation of RNFL thickness by the GDx VCC. Nevertheless, the GDx VCC was found to be as effective as the StratusOCT in detecting the loss of RNFL in glaucoma. (Invest Ophthalmol Vis Sci. 2005;46:3214–3220) DOI:10.1167/iovs.05-0294

Evaluation of the retinal nerve fiber layer (RNFL) is one of the key components in establishing the diagnosis of glaucoma. RNFL atrophy can be detected clinically with fundus photography even before the onset of visual field defect.1,2 Although red-free fundus photography provides qualitative assessment of the RNFL, quantitative measurement can now be performed with high-resolution RNFL imaging devices. Optical coherence tomography (OCT) and scanning laser polarimetry (SLP) are two imaging technologies that were designed to measure peripapillary RNFL thickness. Based on the principle of low-coherence interferometry, OCT measures RNFL thickness by the time-of-flight delay from the backscattering signals, analogous to the ultrasound B scan. The latest model of OCT (StratusOCT; Carl Zeiss Meditec, Dublin, CA) provides optical imaging with an axial resolution of less than 10 μm. The measurement of RNFL thickness is determined by the difference in distance between the vitreoretinal interface and a posterior boundary, based on a predefined reflectivity signal level. In contrast, SLP determines the RNFL thickness based on the birefringence property of the RNFL. It measures the RNFL phase retardation of polarized scanning laser beams, and the thickness is estimated according to the relation: phase retardation = RNFL birefringence × RNFL thickness. RNFL birefringence has been studied in primate eyes with RNFL retardance measured with SLP and RNFL thickness measured in histology sections.3 The calculated birefringence was found to be 0.27 deg/μm or 0.19 nm/μm. The latest version of SLP, the GDx VCC (Laser Diagnostic Technologies, Inc., San Diego, CA) is equipped with a variable corneal compensator allowing individualized compensation of the corneal birefringence effect. A fixed conversion factor of 0.67 nm/μm is used by the GDx VCC for converting RNFL retardance into thickness measurements.4

The peripapillary RNFL profile exhibits a double-hump pattern with maximum RNFL thickness located at the superior and inferior sectors of the optic nerve head, and both StratusOCT and GDx VCC analyze and express the average RNFL thickness in micrometers. However, the RNFL thicknesses measured with these two nerve fiber analyzers have been found to be quite different. With the GDx VCC, it has been reported that the mean peripapillary RNFL thickness (TSNIT) [total average

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superior, nasal, inferior, temporal) in normal individuals ranges between 47.3 and 54.8 μm,5–7 whereas with the StratusOCT, the normal average peripapillary RNFL thickness is in the range of 96.3 to 104.8 μm.5–11 Despite the fact that various studies have demonstrated relatively high diagnostic accuracy for detection of glaucoma with the StratusOCT and GDx VCC,5–11 it is not known whether the measurements of StratusOCT and GDx VCC have any correlation at all. This is an important issue, in view of the substantial differences in the RNFL thickness measurements obtained. In addition, since the respective RNFL profiles may not be exactly the same because of the differences in the principles and methodologies in the RNFL measurements, a detailed analysis of these profiles, and their correlations, would be useful, not only in understanding their relationship but also in providing a basis for the cross-referencing of measurements made by these two different devices. The goal of this study was to investigate the association between GDx VCC and StratusOCT RNFL measurements in each clock hour around the optic nerve head. In addition, the respective diagnostic performance for glaucoma detection was also compared.

**MATERIALS AND METHODS**

**Subjects**

This noninterventional, cross-sectional study included 89 subjects. One eye was selected randomly from each of 27 normal individuals, 21 with suspected glaucoma, and 41 with known glaucoma. All recruited subjects were examined during the period from August to November 2004 in the Department of Ophthalmology of Caritas Medical Centre (Hong Kong), the ophthalmic referral center in the Hong Kong Hospital Authority Kowloon West Cluster, serving a population size of ~1.2 million. The study was conducted in accordance with the ethical standards stated in the 1964 Declaration of Helsinki and approved by the Hong Kong Hospital Authority Kowloon West Cluster Clinical Research Ethics Committee with informed consent obtained.

All subjects underwent a full ophthalmic examination including visual acuity, refraction, intraocular pressure measurement with Goldmann tonometry, and dilated fundus examination with stereoscopic biomicroscopy of the optic nerve head by slit lamp and indirect ophthalmoscopy. The inclusion criteria were best corrected visual acuity no worse than 20/40 and spherical refractive error within the range of −6.00 to +3.00 D. Individuals were excluded if they had a history of any retinal disease, surgery or laser procedures, diabetes mellitus, hypertension, or neurologic diseases. Normal subjects were individuals who visited the clinic during the same recruitment period and were diagnosed to have no ocular or intraocular diseases. In particular, they had no visual field defect based on the Humphrey visual field results, no structural optic disc abnormalities, and no history of intraocular pressure higher than 21 mm Hg. The suspected-glaucoma group consisted of individuals with ocular hypertension and/or preperimetric glaucoma. Ocular hypertension was defined as intraocular pressure greater than 21 mm Hg measured in at least three separate visits. Preperimetric glaucoma was diagnosed in patients when they presented with asymmetric cup-disc ratio of more than 0.2 and showed early glaucomatous optic disc changes, including thinning of neuroretinal rim and notching. However, all subjects belonging to the suspected-glaucoma group had normal visual field results, as in the normal group. Patients with glaucoma had received a diagnosis based on the presence of visual field defects (described later). Among the 41 patients with glaucoma, 21 had primary open-angle glaucoma, 13 had normal-tension glaucoma, 6 had primary angle-closure glaucoma, and 1 had uveitic glaucoma. All recruited subjects had visual field testing performed with the Humphrey Field Analyzer (Humphrey Field Analyzer II, central 24-2, SITA fast test program; Carl Zeiss Meditec, Inc.). A reliable Humphrey visual field test is defined as having less than 20% fixation loss and less than 25% false-positive and false-negative errors.

A visual field defect was defined as having three or more significant (P < 0.05) non-edge-contiguous points with at least one at P < 0.01 on the same side of the horizontal meridian in the pattern deviation plot and classified outside normal limits in the Glaucoma Hemifield Test. Any detected field defect had to be confirmed in at least one consecutive visual field test to be considered abnormal. The latest visual field test obtained within the study period (August to November 2004) was selected for the analysis.

**OCT Measurements**

The StratusOCT, with software version 3.0.1, was included in the study. Detailed descriptions of the optical principles and applications of OCT have been described.12 The RNFL (3.4) scan (with 512 data points) was selected for RNFL measurement. The RNFL thickness was measured by averaging the results of three sequential circular scans of 3.4-mm diameter centered on the optic nerve head. The total average RNFL thickness and the mean clock-hour RNFL measurements are obtained in the analysis printout. A good-quality scan was defined as one with a signal-to-noise ratio of more than 35, 100% accepted A-scans, and good delineation of the anatomic boundaries. Subjects would not be included in the study if they failed to have good-quality OCT images after three attempts. All the OCT scans obtained in the study met the criteria of good-quality scans, and no subjects were excluded.

**SLP Measurements**

SLP measurements were performed with the use of the GDx VCC. The images were analyzed with software version 5.5.0. The principles and applications of SLP have been described elsewhere.13 In brief, scanning beams of near-infrared laser (780 nm) are directed over a 20° to 40° area of the retina, which includes the macula and the optic nerve head. The reflected light that double passes the RNFL is detected, and the retardation is measured. The GDx VCC quantifies the RNFL by first measuring the eye-specific corneal birefringence, which consists of the corneal polarization axis and magnitude. It is determined with a macular image acquired with the retardance of the VCC set to 0. The Henle fiber layer and corneal retardation can then be measured from the macular retardation profile. To ensure accurate corneal measurement, the software provides an image quality check score (1–10) based on the correct alignment, fixation, and refraction of the scan. A score of eight was the minimum standard for good-quality scans in the present study. The variable corneal compensator was then set to neutralize the anterior corneal birefringence, and the retinal retardance was imaged and measured. Nine eyes were excluded from the study because of suboptimal scanning quality secondary to poor fixation, motion artifacts, or overilluminated images. GDx VCC measures the retardation in nanometers and a fixed conversion factor is used to calculate the RNFL thickness in micrometers. The result printout from the GDx VCC analyzes only the TSNIT average (total average RNFL thickness), superior average, inferior average, and the TSNIT standard deviation. In the present study, the raw data from the GDx VCC were also extracted, to reconstitute the 12-clock-hour RNFL measurements so that the respective clock-hour RNFL thickness could be compared. All the measurements (visual field sensitivity and the OCT/SLP-measured RNFL thicknesses) were obtained within the same study period (August to November 2004).

**Statistical Analysis**

Statistical analyses were performed on computer (SPSS ver.11.0; SPSS, Chicago, IL). Differences in the age, refraction, visual field mean deviation (MD), and average RNFL thickness (measured with StratusOCT and GDx VCC) between the diagnostic groups were evaluated with the independent-sample t-test. The area under the receiver operating characteristic curve (AUC) was used to assess the ability to differentiate glaucoma-suspect and glaucomatous eyes from normal eyes of each testing parameter. An AUC of 1.0 represents perfect discrimination and an AUC of 0.5 represents chance discrimination. The method described by Hanley and McNeil14 was used to compare the AUCs. The
relationship between measured parameters and visual field MD and the correspondence between the respective clock-hour RNFL measurements were studied with linear regression analysis. In all statistical analyses, \( P < 0.05 \) was considered statistically significant.

**RESULTS**

**StratusOCT and GDx VCC RNFL Profiles**

There are 4 types of subjects in the study: normal, pre-perimetric glaucoma, ocular hypertension, and glaucoma. Since the main objective of this study is to perform a correlation analysis of RNFL measurements of StratusOCT and GDx VCC, analysis of the 12 clock-hour RNFL profile and the diagnostic performance of StratusOCT and GDx VCC was performed only between normal and the abnormal (pre-perimetric glaucoma, ocular hypertension and glaucoma) groups. The baseline characteristics of the studied subjects are presented in Table 1. For StratusOCT, the average RNFL thickness in the normal and suspected-glaucoma/glaucoma groups were 101.38 ± 7.73 and 76.04 ± 20.13 \( \mu \)m, respectively. In contrast, they were measured to be 55.26 ± 4.32 and 43.50 ± 9.72 \( \mu \)m, respectively, by the GDx VCC. The RNFL profiles of each of the diagnostic groups are plotted and shown in Figure 1. RNFL thickness measured by the StratusOCT was significantly higher than that measured by the GDx VCC in both the normal and the suspected-glaucoma/glaucoma groups (all with \( P < 0.001 \)) in each clock hour. Both nerve fiber analyzers demonstrated double-hump patterns in the RNFL profiles. In normal subjects, the peaks were located at the inferotemporal (7 o'clock) and the superotemporal (11 o'clock) clock hours by StratusOCT, whereas they were located at the superior (12 o'clock) and the inferior (6 o'clock) clock hours by GDx VCC. The troughs were located at the nasal (3 o'clock) and temporal (9 o'clock) clock hours in the RNFL profiles of both StratusOCT and GDx VCC. (The clock hours are aligned based on the right eye’s orientation: 12 o’clock corresponds to the superior region, 3 o’clock to the nasal, 6 o’clock to the inferior, and 9 o’clock to temporal, in both eyes.)

**Diagnostic Performance of StratusOCT and GDx VCC**

The AUC of total average, mean quadratic, and mean clock-hour RNFL thickness for discriminating suspected-glaucoma/glaucoma patients from normal eyes were calculated and tabulated in Table 2. For GDx VCC, the highest AUCs were found in the superior RNFL measurement (AUC = 0.909) and the nerve fiber indicator (AUC = 0.907). In contrast, the 7 o’clock RNFL thickness, corresponding to the inferotemporal sector, achieved the highest AUC (0.901) among all the StratusOCT measurements. No significant difference was found in comparing the best parameters of GDx VCC and StratusOCT (\( P = 0.861 \)).

**Correlation Analysis of StratusOCT and GDx VCC RNFL Measurements**

The scatterplot of average RNFL thickness (TSNIT Average) measured by GDx VCC against the average RNFL thickness measured by StratusOCT in all subjects studied is shown in Figure 2. Linear regression analysis revealed a high correlation between the average RNFL measurements, with a correlation coefficient of 0.852. Table 3 presents the clock-hour RNFL correlations between the two nerve fiber analyzers and the corresponding linear regression equations. The correlation coefficients were found to vary with the position of the optic nerve head, with the highest in the superior and inferior clock hours and the lowest in the temporal and nasal clock hours (Fig. 3). The slope of the linear regression equations followed similar patterns, with peaks in the superior and inferior sectors and the troughs in the nasal and temporal sectors.

**DISCUSSION**

The use of modern imaging devices in the evaluation of patients with glaucoma is becoming popular, and their role in early detection and monitoring of glaucoma has been evolving. Clinical guidelines from the American Academy of Ophthalmology and the European Glaucoma Society state that the use of these newer quantitative approaches is helpful in the documentation of glaucomatous changes and may aid in the clinical management of glaucoma. OCT and SLP are two different imaging modalities designed to analyze the peripapillary RNFL thickness and the StratusOCT and GDx VCC are the two latest commercially available models, with improved imaging capacity compared with earlier generations. Various studies have found relatively high diagnostic performance in glaucoma detection with the GDx VCC and StratusOCT. With the use of the prototype GDx VCC, Weinreb et al. showed that the superior quadrant average RNFL thickness had the largest AUC (0.83) for discriminating 54 glaucomatous eyes (average visual field MD in the glaucoma group = −6.49 dB) from 40 healthy eyes. Reus and Lemij also found high discriminating power in detecting primary open-angle glaucoma (average visual field MD = −8.45 dB) with the use of GDx VCC. The AUCs of total average RNFL thickness, superior RNFL thickness, inferior RNFL thickness, and nerve fiber indicator (NFI) were found to be 0.93, 0.94, 0.90, and 0.98, respectively. The diagnostic sensitivity of the StratusOCT for glaucoma detection was published only recently. In a group of 63 subjects with glaucoma with visual field MD of −8.4 dB, Budenz et al. reported that the average RNFL thickness and the inferior quadrant RNFL thickness achieved the highest AUCs (0.966 and 0.971, respectively, respectively). Meideiros et al. arrived at a similar conclusion in showing that the inferior (AUC = 0.91) and the average (AUC = 0.91) RNFL thickness had the best discriminating power for detection of glaucoma, with an average visual field MD of −4.96 dB. Although most of the studies focused on either OCT

**Table 1. Subject Characteristics**

<table>
<thead>
<tr>
<th>Subjects (n)</th>
<th>Normal</th>
<th>Suspected Glaucoma and Glaucoma</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean y ± SD)</td>
<td>47.9 ± 13.8</td>
<td>58.0 ± 13.5</td>
<td>0.002</td>
</tr>
<tr>
<td>Refraction (mean D ± SD)</td>
<td>−0.37 ± 2.17</td>
<td>−0.42 ± 2.75</td>
<td>0.931</td>
</tr>
<tr>
<td>Visual field MD (mean dB ± SD)</td>
<td>−1.47 ± 1.03</td>
<td>−0.870 ± 0.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TSNIT average (GDx VCC) (( \mu )m)</td>
<td>55.26 ± 4.32</td>
<td>43.50 ± 9.72</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Average RNFL thickness (StratusOCT) (( \mu )m)</td>
<td>101.38 ± 7.73</td>
<td>76.04 ± 20.13</td>
<td>&lt;0.001</td>
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</table>

* Independent-sample t-test.
or SLP, only a few compared the respective diagnostic performance in the same study population. Greaney et al. compared the discriminant analysis on RNFL thickness measured with the earlier versions of SLP (GDx with fixed corneal compensator) and OCT (OCT 1) and found that the OCT 1-measured RNFL thickness (AUC = 0.88) was significantly inferior to the GDx RNFL thickness (AUC = 0.94) for discrimination of glaucoma (average visual field MD = −3.9 dB). At the time of this writing, only one study had been performed to compare the AUCs of GDx VCC and StratusOCT. Medeiros et al. reported that the highest AUCs for the GDx VCC and StratusOCT in glaucoma detection (average visual field MD = −4.87 dB) were the NFI (AUC = 0.91) and the inferior RNFL thickness (AUC = 0.92), respectively, and no significant difference in the AUCs was found. In agreement with the previous studies, we demonstrated the inferotemporal RNFL thickness (at 7 o'clock, right-eye orientation) in StratusOCT, and the NFI and the superior RNFL thickness in GDx VCC, had the highest performance (all with AUCs >0.90) to discriminate the normal from suspected-glaucoma and glaucoma groups. In addition, we did not find significant difference in comparing the best parameters from StratusOCT and GDx VCC. The findings of higher diagnostic performance based on the superior and inferior, rather than the temporal and nasal, RNFL measurements are in concordance with the observations that the superior and infe-

![Figure 1](https://www iovs arvojournals org)
Previous investigations on the histomorphometric measurement of peripapillary RNFL in human eyes yielded different RNFL thickness measurements. The mean RNFL thickness was estimated to be 215 and 367 μm in studies by Dichtl et al. and Varma et al. respectively. Their findings are in contrast to the in vivo measurements of 101.38 and 55.26 μm with the use of StratusOCT and GDx VCC, respectively, in the present study. Although both nerve fiber analyzers underestimated RNFL thicknesses compared with the histologic measurements, it is apparent that OCT provides a closer estimation. It is still uncertain whether the length of postmortem time and the methods of fixing and staining the histologic sections would have any effect on the true thickness measurements. Nevertheless, the findings of the maximum RNFL thickness over the inferotemporal sector, followed by the superotemporal sector and minimum over the nasal sector in the StratusOCT RNFL profile are in close agreement with the red-free photographic studies in the human RNFL.

In both the normal and the suspected-glaucoma/glaucoma groups, significant differences were found between the StratusOCT and the GDx VCC, in the total average and in each clock-hour RNFL thickness (all with P < 0.001). For StratusOCT, a scanning circle with a 1.7-mm radius centered at the optic disc was used for the RNFL measurements, whereas in GDx VCC, a circular area with an outer radius of

<table>
<thead>
<tr>
<th>Location</th>
<th>GDx VCC</th>
<th>Stratus OCT</th>
</tr>
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<tbody>
<tr>
<td>12 O’clock</td>
<td>0.893 ± 0.045</td>
<td>0.796 ± 0.046</td>
</tr>
<tr>
<td>1 O’clock</td>
<td>0.852 ± 0.046</td>
<td>0.803 ± 0.045</td>
</tr>
<tr>
<td>2 O’clock</td>
<td>0.659 ± 0.058</td>
<td>0.718 ± 0.055</td>
</tr>
<tr>
<td>3 O’clock</td>
<td>0.508 ± 0.067</td>
<td>0.627 ± 0.061</td>
</tr>
<tr>
<td>4 O’clock</td>
<td>0.654 ± 0.066</td>
<td>0.619 ± 0.062</td>
</tr>
<tr>
<td>5 O’clock</td>
<td>0.857 ± 0.045</td>
<td>0.784 ± 0.047</td>
</tr>
<tr>
<td>6 O’clock</td>
<td>0.823 ± 0.043</td>
<td>0.817 ± 0.045</td>
</tr>
<tr>
<td>7 O’clock</td>
<td>0.751 ± 0.051</td>
<td>0.901 ± 0.031</td>
</tr>
<tr>
<td>8 O’clock</td>
<td>0.498 ± 0.070</td>
<td>0.706 ± 0.054</td>
</tr>
<tr>
<td>9 O’clock</td>
<td>0.703 ± 0.062</td>
<td>0.618 ± 0.061</td>
</tr>
<tr>
<td>10 O’clock</td>
<td>0.650 ± 0.061</td>
<td>0.789 ± 0.050</td>
</tr>
<tr>
<td>11 O’clock</td>
<td>0.845 ± 0.041</td>
<td>0.852 ± 0.042</td>
</tr>
<tr>
<td>Average</td>
<td>0.876 ± 0.036</td>
<td>0.852 ± 0.040</td>
</tr>
<tr>
<td>Superior</td>
<td>0.909 ± 0.030</td>
<td>0.857 ± 0.040</td>
</tr>
<tr>
<td>Nasal</td>
<td>0.662 ± 0.059</td>
<td>0.686 ± 0.056</td>
</tr>
<tr>
<td>Inferior</td>
<td>0.858 ± 0.041</td>
<td>0.865 ± 0.038</td>
</tr>
<tr>
<td>Temporal</td>
<td>0.503 ± 0.066</td>
<td>0.752 ± 0.053</td>
</tr>
<tr>
<td>Nerve fiber indicator</td>
<td>0.907 ± 0.031</td>
<td>—</td>
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Data are expressed as AUC ± SE. Bold data denote the parameter with the largest AUC for each imaging device.

![Figure 2](https://via.placeholder.com/150)

**FIGURE 2.** Scatterplot of the total average RNFL thickness measured by GDx VCC against the total average measured by StratusOCT.
1.628 mm and an inner radius of 1.256 mm was used for calculation of RNFL thickness. Theoretically, RNFL thickness measured by GDx VCC should be slightly higher than that measured by StratusOCT because of the closer proximity of the GDx VCC calculation circle toward the optic disc; but the fact is, for the total average RNFL thickness, StratusOCT measured at a value nearly double that measured by GDx VCC. Although the discrepancy may be explained by the underlying differences in the measuring principles and the methodologies in the calculation of RNFL thickness between OCT and SLP, the substantial differences in measurements of RNFL thickness raise concerns about the correspondence of the respective RNFL measurements. A correlation analysis on the RNFL measurements would therefore be essential to provide a vital link for the understanding and interpretation of the different RNFL thickness analysis results generated by OCT/SLP. In the present study, the respective average RNFL thicknesses correlated highly, with the correlation coefficient reaching 0.852 (Fig. 2). However, when individual clock-hour measurements were compared, the correlation coefficient varied with the positions around the optic nerve head, with the highest correlations found over the superior and inferior clock hours (11, 12, 1, 6, and 7 o’clock; all with \( r > 0.700 \)) and the lowest at the temporal clock hour (9 o’clock; \( r = 0.277 \); Fig. 3). Although it is difficult to explain the differences in correlations without having a gold standard for true thicknesses, we believe the regional variability in the RNFL measurements and the variation of the optic nerve head birefringence around the optic nerve head are responsible for the observation. Being the thinnest portions in the RNFL profile, the nasal and temporal sectors have been reported to have higher variability in the OCT and SLP RNFL measurements.\(^{23-28}\) It has been proposed that the anatomic variations in the blood vessels and the peripapillary atrophy over the nasal and temporal quadrants can create measurement errors and thus result in lower reproducibility. Therefore, lower correlation of the OCT and SLP RNFL measurements would be expected over the nasal and temporal areas.

Similar patterns were observed in the slope of the linear regression equations describing the relationship between OCT and SLP RNFL measurements. The range of the slopes varied from 0.40 to 0.45 in the superior clock hours (11–2 o’clock) and 0.36 to 0.40 in the inferior clock hours (7–8 o’clock). The 3, 9, and 10 clock hours demonstrated the lowest values at 0.27, 0.20, and 0.31 respectively. The implication is that SLP RNFL measurement does not have a fixed relationship with OCT RNFL measurement. Sectors with thicker RNFL may well demonstrate different birefringence properties from areas with a thinner RNFL. Two independent studies with different methodologies were published recently that demonstrated that the RNFL birefringence varies with the position around the optic nerve head in human subjects.\(^{29,30}\) Using custom-made software to register the RNFL retardance and thickness with SLP and OCT, respectively, at a specific scan path, Huang et al.\(^{30}\) showed that RNFL birefringence is highest in the superior and inferior quadrants and lowest in the temporal and nasal quadrants, with a mean of \( 0.32 \pm 0.03 \) nm/μm. Cense et al.\(^{29}\) arrived at the same conclusion with the use of polarization-sensitive OCT, which combines the RNFL thickness and birefringence measurements along a peripapillary circular scan. In particular, they reported that the standard error measurements of RNFL birefringence were lowest over the superior and inferior sectors around the optic nerve head, suggesting that RNFL birefringence measurements were most reliable in the thicker areas of the RNFL. The higher correlations found over the superior and inferior sectors in the present study reflect that the use of the default birefringence conversion factor (0.67 nm/μm) in GDx VCC achieves better correspondence with StratusOCT in these sectors. In the study by Huang et al.,\(^ {30}\) two study groups (12 eyes in group 1 and 11 eyes in group 2) from two different study sites were selected for the analysis. The superior, nasal, inferior, and temporal RNFL birefringence were 0.42, 0.29, 0.44, and 0.25 nm/μm, respectively, in group 1 and 0.33, 0.23, 0.37, and 0.21 nm/μm, respectively, in group 2. Therefore, the use of the fixed conversion factor of 0.67 nm/μm for the GDx VCC may be higher than the RNFL birefringences needed to match the StratusOCT measurements, and the calculation of RNFL thickness would be less accurate, particularly over the nasal and temporal sectors.

Collectively, our findings demonstrated that GDx VCC and StratusOCT RNFL measurements correlated significantly, even though there were substantial differences in RNFL thickness. With reference to human histology studies, StratusOCT provides a closer estimation of RNFL thickness than does GDx VCC. Nevertheless, it was supported by the present study that the current GDx VCC system would be as sensitive as Stratus-OCT in detecting RNFL reduction in glaucoma and the use of GDx VCC for evaluation of glaucoma remains clinically sound.

References


