Effect of Moderate Intraocular Pressure Changes on Topographic Measurements With Confocal Scanning Laser Tomography in Patients With Glaucoma

Marcelo T. Nicolela, MD; Adael S. Soares, MD; Monica M. Carrillo, MD; Balwantray C. Chauhan, PhD; Raymond P. LeBlanc, MD; Paul H. Artes, PhD

Objective: To evaluate optic disc topography changes after intraocular pressure (IOP) modulation in patients with glaucoma.

Methods: Twenty-three patients with glaucoma were studied. Three mean optic disc topography images were obtained with the Heidelberg Retina Tomograph II at baseline and weeks 1, 2, 4, and 8 (visits 1, 2, 3, 4, and 5, respectively). Topical medications were discontinued in the study eye after visit 1 and resumed after visit 4 but maintained in the contralateral control eye. Central corneal thickness was measured at the last visit. Topographic changes were determined by stereometric parameters (rim area and mean cup depth) and at discrete topographic locations using the Topographic Change Analysis program (from the Heidelberg Retina Tomograph II).

Results: In the study eyes, IOP increased significantly (5.4 mm Hg at visit 4; \( P < .001 \)) after withdrawal of topical medications but returned to baseline levels after resuming medications; no statistically significant topographic changes, however, were observed. Moreover, no relationship between change in IOP and stereometric parameters was observed. Central corneal thickness was not associated with changes in optic disc topography induced by IOP modulation.

Conclusion: In patients with glaucoma, significant but relatively moderate IOP increases and decreases on the order of 5 mm Hg did not appear to have an effect on optic disc topography.


CONFOCAL SCANNING LASER tomography is becoming a widely used technique for obtaining topographic images of the optic disc and peripapillary retina in patients with glaucoma. The reproducibility of this technique has been evaluated both in normal subjects and in patients with glaucoma, with variability of stereometric optic disc parameters on the order of 3% to 5%. Because of its good reproducibility characteristics, this technique has the potential of being an excellent tool for monitoring optic disc status in progressive optic neuropathies such as glaucoma. Several studies have reported promising results on the ability of confocal scanning laser tomography to identify topographic changes over time in patients with glaucoma and ocular hypertension, using analysis techniques based on change of stereometric parameters or of discrete topographic locations.

Previous reports have shown that optic disc topography can be influenced by intraocular pressure (IOP), with decreased IOP shifting the lamina cribrosa forward (ie, decreasing optic disc rim and increasing optic disc cup) and increased IOP shifting the lamina cribrosa backward (ie, decreasing optic disc rim and increasing optic disc cup). Most of these studies evaluated changes in IOP following glaucoma surgery, which typically produces a pronounced decrease in IOP, but topographic optic disc changes have also been observed after medical manipulation of IOP.

Intraocular pressure is known to fluctuate during and between different days, more so in subjects with glaucoma or ocular hypertension than in healthy individuals. Moreover, patients with glaucoma often experience IOP changes induced by alterations in their medical therapy, which could potentially induce confounding effects on disc topography that are purely mechanical and not due to glaucomatous progression. It is important, therefore, to evaluate the effects of IOP fluctuation on confocal scanning laser tomography if this technique is used to monitor optic disc progression clinically.

The objective of the present study was to evaluate optic disc topography changes induced by increasing and decreasing IOP in one eye of patients with glaucoma while using the contralateral eye as a control. Analyses based both on stereometric parameters and on change of discrete topographic loca-
CCT would influence changes in optic disc topography in-

as a surrogate index of scleral or lamina cribrosa thickness

independent from its effect on IOP, by serving, for instance,

planation tonometry in these eyes. It has also been postu-

be related to the underestimation of IOP measured by ap-

influences the IOP-induced changes on optic disc topogra-

we wanted to evaluate if central corneal thickness (CCT)

sation in some studies16,17 but not in others.18,19 It is thought

cause they are clinically meaningful, well understood, are

cause to directly reflect lamina cribrosa shifts induced by

in IOP, and tend to have lower variability than oth-

erwise reducing variability between visits. Topographical changes

were calculated by subtracting the baseline median value from

the median value at each visit so that negative values refer to a

reduction and positive values to an increase, with respect to

the baseline visit. Changes were analyzed in absolute units (eg, in

millimeters of mercury for IOP and millimeters squared for optic disc rim area) as well as in relative units (percentage of change from baseline).

The current version of the HRTII software provides for 2
different reference planes on which some of the stereometric indexes are based.20 Since the reproducibility of the optic disc rim area measurements within each visit was significantly better with the 320-µm reference plane compared with the standard reference plane (mean coefficient of variation of the median value in the control eyes, 2.4% and 3.3%, respectively; *P*<.002, Wilcoxon), the analyses reported in this article refer to the data obtained with the 320-µm reference plane.

Optic disc changes were also evaluated using the probability maps of the TCA program, which compare the relative height of each superpixel in the follow-up images with that of the baseline image.21 Areas with statistically significant depression or elevation on 3 consecutive mean topographies are highlighted in red or green, respectively.3 Because we obtained 3 consecutive mean topographies during each visit, we were able to use the last image obtained in each visit (which would represent consecutive changes that occurred in all 3 images from that visit) and compare it with the baseline image. Custom software written in Matlab (version 6; MathWorks, Natick, Mass) was used to calculate the size of the largest cluster of red and green superpixels within the contour line. The size of the clusters was expressed as a proportion of the total number of superpixels within the disc area to account for the possible large variation in disc size between patients. As with the stereometric analysis, we related the size of the largest cluster of red and green superpixels within the optic disc area to the observed IOP changes.

Changes in the investigated variables (IOP, optic disc rim area, mean cup depth) during the 5 visits were evaluated statistically by repeated-measures analysis of variance (ANOVA) using the General Linear Model module of SPSS version 12.0 (SPSS Inc, Chicago, Ill). Differences between study and control eyes and changes of the investigated variables between 2 study visits in the same group of eyes were evaluated statistically with the Wilcoxon test. The influence of CCT on changes of stereometric parameters was evaluated by multivariate analysis, with IOP and CCT as covariates.

**METHODS**

**PATIENTS**

Twenty-three patients with glaucoma who were receiving bi-
lateral topical therapy to lower IOP were recruited for this study

from the glaucoma practices of 2 of us (M.T.N. and R.P.L.).

Inclusion criteria were (1) diagnosis of open-angle glaucoma,

defined as presence of typical features of glaucomatous optic
disc damage (including documented progressive cupping and

presence of optic disc notching) with a damaged visual field in

at least one eye (defined as presence of an abnormal Glau-

coma Hemifield Test result) and open angles on gonioscopy;

(2) clear media; and (3) IOP controlled with at most 2 topical

medications. Patients in whom visual fields in both eyes had a

mean deviation worse than −12 dB and/or had involvement of

1 of the 4 paracentral points were excluded from the study. The

study protocol was approved by the Queen Elizabeth II Health

Sciences Centre Research Ethics Committee and was carried

out in adherence with the tenets of the Declaration of Hel-

sinki. Informed consent was obtained from all subjects.

**PROCEDURES**

The patient’s least damaged eye was chosen as the study eye in

cases of disease asymmetry (defined as mean deviation differ-

cence between the 2 eyes > 2 dB); otherwise, the study eye was

randomly assigned. After the baseline visit (visit 1), topical medi-
cations were discontinued in the study eye. The fellow eye was

maintained on its regular therapy. Patients were then reexam-

ined after 1, 2, and 4 weeks (visits 2, 3, and 4, respectively).

After visit 4, medications were resumed in the study eye and

patients attended a final study visit 4 weeks later (visit 5).

At each visit, 3 mean topography images were obtained with

the HRTII, followed by IOP measurements using Goldmann ap-

planation tonometry to minimize the effects of corneal stain-

ing after 1 month for visit 5. Central corneal thickness was mea-

ured after 1, 2, and 4 weeks (visits 2, 3, and 4, respectively; 

(mean in millimeters) for IOP and millimeters squared for optic disc rim area during the 5 visits were evaluated statistically by repeated-measures analysis of variance (ANOVA) using the General Linear Model module of SPSS version 12.0 (SPSS Inc, Chicago, Ill). Differences between study and control eyes and changes of the investigated variables between 2 study visits in the same group of eyes were evaluated statistically with the Wilcoxon test. The influence of CCT on changes of stereometric parameters was evaluated by multivariate analysis, with IOP and CCT as covariates.

**ANALYSIS**

Two experienced observers (M.T.N. and M.M.C.) reviewed the HRT images, drew the contour lines to outline the optic disc boundary, and checked the alignment of the image series, making manual alignment corrections where necessary.

Stereometric indexes were exported using version 1.4.1.0

of the Heidelberg Eye Explorer software. The HRT software pro-

vides many global and sectorial indexes of optic disc topogra-

phy, many of which are highly related, but we decided when

the study was designed to report on the global rim area and

mean cup depth indexes only. These indexes were chosen be-

cause they are clinically meaningful, well understood, are

thought to directly reflect lamina cribrosa shifts induced by

changes in IOP, and tend to have lower variability than others.

We specifically avoided analyzing all global and sectorial indexes provided by this instrument because we would end up with several comparisons and, by chance alone, we would expect to find significant differences in some of them. We used the median value of the 3 mean topography images obtained at each visit to reduce the effect of occasional outliers, therefore reducing variability between visits. Topographical changes were calculated by subtracting the baseline median value from the median value at each visit so that negative values refer to a reduction and positive values to an increase, with respect to the baseline visit. Changes were analyzed in absolute units (eg, in millimeters of mercury for IOP and millimeters squared for optic disc rim area) as well as in relative units (percentage of change from baseline).

The current version of the HRTII software provides for 2 different reference planes on which some of the stereometric indexes are based.20 Since the reproducibility of the optic disc rim area measurements within each visit was significantly better with the 320-µm reference plane compared with the standard reference plane (mean coefficient of variation of the median value in the control eyes, 2.4% and 3.3%, respectively; *P*<.002, Wilcoxon), the analyses reported in this article refer to the data obtained with the 320-µm reference plane.

Optic disc changes were also evaluated using the probability maps of the TCA program, which compare the relative height of each superpixel in the follow-up images with that of the baseline image.21 Areas with statistically significant depression or elevation on 3 consecutive mean topographies are highlighted in red or green, respectively.3 Because we obtained 3 consecutive mean topographies during each visit, we were able to use the last image obtained in each visit (which would represent consecutive changes that occurred in all 3 images from that visit) and compare it with the baseline image. Custom software written in Matlab (version 6; MathWorks, Natick, Mass) was used to calculate the size of the largest cluster of red and green superpixels within the contour line. The size of the clusters was expressed as a proportion of the total number of superpixels within the disc area to account for the possible large variation in disc size between patients. As with the stereometric analysis, we related the size of the largest cluster of red and green superpixels within the optic disc area to the observed IOP changes.

Changes in the investigated variables (IOP, optic disc rim area, mean cup depth) during the 5 visits were evaluated statistically by repeated-measures analysis of variance (ANOVA) using the General Linear Model module of SPSS version 12.0 (SPSS Inc, Chicago, Ill). Differences between study and control eyes and changes of the investigated variables between 2 study visits in the same group of eyes were evaluated statistically with the Wilcoxon test. The influence of CCT on changes of stereometric parameters was evaluated by multivariate analysis, with IOP and CCT as covariates.
CHANGE IN IOP

In the study eyes, the IOP increased significantly at visits 2, 3, and 4 (P < .001). At visit 4, for example, 4 weeks after the baseline visit (visit 1), the IOP in the study eyes had increased, on average, by 5.4 mm Hg, or 33% (Figure 1A and C). At visit 5, 4 weeks after medications had been resumed, the IOP in the study eyes decreased significantly compared with visit 4 (mean ± SD, 22.27 ± 4.12 mm Hg and 17.99 ± 2.67 mm Hg for visits 4 and 5, respectively; P < .001) but was not significantly different than visit 1 (P = .55). In the control eyes, the IOP did not vary significantly during the 5 visits (P > .22) (Figure 1B and D).

VARIATION IN STEREOMETRIC PARAMETERS DURING THE 4 FOLLOW-UP VISITS

In the study eyes, repeated-measures ANOVA did not reveal any significant changes in rim area and mean cup depth during the 5 visits (all P > .42) (Figure 2). In the control eyes, no significant changes were observed in rim area during the 5 visits (P = .39), but a borderline statistical significance (P = .04) was observed in changes of mean cup depth, most likely a false-positive finding caused by outliers. The data points in Figure 2, for example, show the individual rim area changes as compared with baseline during visits 2 to 5. In the study eyes, none of the group means (shown by horizontal lines) were statistically different from zero, irrespective of whether the changes were expressed in absolute (millimeters squared) or relative (percentage) terms. All mean changes were small compared with the spread of individual data points. Similar findings were obtained with mean cup depth (Figure 3). The analysis performed using the standard reference plane showed similar results (data not shown).

VARIATION IN TCA PROBABILITY MAPS DURING THE 4 FOLLOW-UP VISITS

We also evaluated the sizes of the largest clusters of red and green superpixels within the optic disc (Figure 4).

Table 1: Baseline Characteristics of Study and Control Eyes*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study Eyes</th>
<th>Control Eyes</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline IOP, mm Hg</td>
<td>17.30 ± 3.27 (14 to 26)</td>
<td>17.17 ± 3.43 (10 to 24)</td>
<td>.67</td>
</tr>
<tr>
<td>CCT, µm</td>
<td>540 ± 31 (470 to 586)</td>
<td>540 ± 33 (458 to 591)</td>
<td>.73</td>
</tr>
<tr>
<td>Refractive error, D</td>
<td>−0.10 ± 2.18 (−4.00 to +4.00)</td>
<td>−0.50 ± 2.10 (−3.50 to +4.00)</td>
<td>.04</td>
</tr>
<tr>
<td>MD, dB</td>
<td>−2.1 ± 2.3 (−11.1 to +1.0)</td>
<td>−4.6 ± 6.3 (−24.2 to +6.8)</td>
<td>.07</td>
</tr>
<tr>
<td>Disc area, mm</td>
<td>2.14 ± 0.45 (1.49 to 3.10)</td>
<td>2.20 ± 0.46 (1.20 to 3.15)</td>
<td>.44</td>
</tr>
<tr>
<td>Rim area, mm</td>
<td>1.32 ± 0.46 (0.69 to 2.81)</td>
<td>1.21 ± 0.32 (0.66 to 1.77)</td>
<td>.54</td>
</tr>
<tr>
<td>RAD, SD</td>
<td>−1.38 ± 1.42 (−4.96 to 1.60)</td>
<td>−1.89 ± 1.33 (−5.07 to 0.91)</td>
<td>.19</td>
</tr>
</tbody>
</table>

Abbreviations: CCT, central corneal thickness; D, diopter; IOP, intraocular pressure; MD, mean deviation; RAD, rim area deviation; SD, standard deviation.

*Data are expressed as mean ± SD (range) unless otherwise specified.
†Wilcoxon test.

Figure 1. Change in intraocular pressure (IOP) from baseline in study (A and C) and control (B and D) eyes in absolute (millimeters of mercury) (A and B) and relative (percentage) (C and D) terms. Withdrawal of topical medications increased IOP by approximately 5 mm Hg (means, solid horizontal lines [A]) or 30% (means, solid horizontal lines [C]) in visits 2 to 4. The IOP returned to baseline levels at visit 5, 4 weeks after medications were resumed. In the fellow eyes, which continued therapy throughout the study, no systematic changes of IOP were observed (B and D).
The mean total number of superpixels within the contour line in the studied eyes was 1105 (range, 655 to 1670). Several study eyes showed red cluster sizes greater than 2% of the superpixels within the contour line in visits 2 to 4, suggestive of significant depression compared with baseline. However, this also occurred in the control eyes and is therefore unlikely to be due to the effect of IOP increase alone. Similar to the findings with the stereometric parameters, there were no clearly apparent differences in the study eyes between visits 2 to 4 (elevated IOP) and visit 5 (when IOP decreased back to baseline levels). Although the clusters appeared slightly larger in the study eyes as compared with the control eyes (Figure 4), this was not statistically significant in a pairwise analysis ($P = .16$). There were also no statistical differences in the cluster sizes with green superpixels between study and control eyes ($P = .65$).

Figure 4 shows an example of the images obtained through the 5 visits in the study eye of 1 patient, with the corresponding TCA obtained on the third image for each visit compared with baseline. In this particular example, we could not observe change in optic disc topography either by TCA or stereometric parameters, despite an IOP increase of 8 to 9 mm Hg after cessation of topical therapy.

**RELATIONSHIP BETWEEN TOPOGRAPHICAL CHANGES, IOP CHANGES, AND CCT**

Despite the moderate IOP modulation in the study eyes, we did not find evidence for a relationship between change in IOP and change in rim area or mean cup depth in the study eyes (Table 2) (Figure 6).
In a multivariate analysis including change in IOP (using data from the visit with the highest change in IOP as compared with baseline) and CCT as covariates, CCT did not exert a statistically significant effect (P > .31) on the relationship between IOP change and change in rim area (Figure 7) or mean cup depth (data not shown).

**Table 2. Correlation Between Absolute Change in Stereometric Parameters and TCA and Absolute Change in IOP**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Study Eyes</th>
<th></th>
<th>Control Eyes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correlation</td>
<td>P Value</td>
<td>Correlation</td>
<td>P Value</td>
</tr>
<tr>
<td>Rim area</td>
<td>0.116</td>
<td>.28</td>
<td>0.071</td>
<td>.51</td>
</tr>
<tr>
<td>Mean cup depth</td>
<td>-0.029</td>
<td>.79</td>
<td>0.086</td>
<td>.42</td>
</tr>
<tr>
<td>Red superpixels</td>
<td>-0.021</td>
<td>.85</td>
<td>0.132</td>
<td>.21</td>
</tr>
<tr>
<td>Green superpixels</td>
<td>0.087</td>
<td>.42</td>
<td>0.126</td>
<td>.24</td>
</tr>
</tbody>
</table>

Abbreviations: IOP, intraocular pressure; TCA, topographic change analysis.

* Using data from visit with highest IOP compared with baseline visit.
Similarly, we did not find evidence for systematic changes in the TCA probability maps with IOP fluctuation (Table 2) (Figure 8). The variation in IOP explained less than 1% of the variation in the superpixel cluster size.

STATISTICAL POWER

We analyzed the statistical power of our study to detect various magnitudes of change in the stereometric parameters rim area and mean cup depth based on the variability observed in the control eyes. For simplicity, we based our power calculations on a paired t test, although our analyses using repeated-measures ANOVA would yield slightly higher power. From Figure 9 it is apparent that our study was adequately powered to detect small changes in rim area and mean cup depth (for example, the power to detect an absolute change of >0.02 mm or relative change >2.5% was >80%, with an α of .05), if such systematic changes had existed.

In this study, the IOP in the study eyes increased on average 5.4 mm Hg (33%) by visit 4 and decreased by the same amount on visit 5, while remaining fairly constant in the control eyes. Despite these significant IOP increases and decreases in the study eyes, no significant topographic changes were observed in the optic discs. We evaluated topographic disc changes with both a global (stereometric parameters) and a discrete (TCA) analysis. This study was well powered to detect relatively small

Figure 6. Relationship between change in neuroretinal rim area (RA) vs change in intraocular pressure (IOP) in the study (A and C) and control (B and D) eyes. We included data from all Heidelberg Retina Tomograph images obtained at each visit. There was no relationship between change of IOP and change in RA, whether changes were expressed in absolute (millimeters squared) (A and B) or relative (percentage) (C and D) terms.

Figure 7. Relationship between relative (percentage) rim area (RA) (A and B) change observed at highest intraocular pressure (IOP) (in relation to baseline measurements) vs central corneal thickness (CCT) in study (A) and control (B) eyes. No significant correlation was observed between the changes in RA induced by IOP elevation and CCT.

Figure 8. Relationship between size of the largest cluster of red (A and B) and green (C and D) superpixels within the optic disc area vs change in intraocular pressure (IOP). A and C, Study eyes. B and D, Control eyes.

Figure 9. Power of this study in detecting changes in rim area (RA) and mean cup depth (MCD) according to different effect sizes, both for absolute change (A) and relative change (B).
changes in the stereometric parameters evaluated, had they occurred (Figure 8). The changes we observed in IOP were relatively modest, albeit statistically significant, and it is possible that with more marked IOP increase and decrease we would observe corresponding changes in optic disc topography. The magnitude of the IOP changes observed in this study, however, mimics what can occur in patients being treated medically, for instance after initiating or adding therapy in patients with elevated IOP or by IOP fluctuations caused by poor compliance with medical therapy. Our results suggest that IOP increases or decreases of this magnitude, sustained for a period of a few weeks, do not affect optic disc topography measured with the HRT in a meaningful or consistent manner. We only evaluated optic disc topography after a few weeks of consistent IOP change; therefore, we cannot rule out the possibility that acute IOP changes of similar magnitude might lead to topographic optic disc changes that did not persist after few weeks.

One of the factors that can influence the ability to detect changes in stereometric parameters over time is variability of the reference plane that is used to define most of the parameters. The standard reference plane of the HRT II is defined as 50 µm below the height of the contour line between 350° and 356°, which is assumed to correspond to the height of the papillomacular nerve fiber bundle, supposedly only affected in very advanced stages of glaucoma. Another approach presently available in the HRT software is to use a fixed reference plane, set at 320 µm. There is currently no agreement regarding the ideal reference plane for HRT analysis, and several investigators have proposed new ways of calculating reference planes, not yet fully evaluated or available in the HRT software. For this reason, we decided to evaluate changes in stereometric parameters using the 2 available reference planes, the standard and the fixed one at 320 µm. Since the variability we observed was smaller with the fixed reference plane, we presented our results using this reference plane, although an analysis based on the standard reference plane yielded similar results. The TCA program, which evaluated change in discrete topographic locations as opposed to stereometric parameters, is independent of any reference plane.

Other investigators have evaluated topographic changes following IOP reduction, with variable results. Iraí et al reported a significant decrease in cup area and cup volume following trabeculectomy with a follow-up of 4 months (average IOP reduction of 11 mm Hg or approximately 45%). In contrast, Topouzis et al reported no significant topographic changes 4 and 8 months after trabeculectomy, despite IOP reduction of approximately 49%. Lesk et al, in a similar study, observed a significant correlation between topographic changes and percentage of IOP reduction following trabeculectomy, with a mean follow-up of 26 weeks. Bowd et al failed to show a significant change in topographic parameters after reducing IOP with topical latanoprost (mean reduction of 25%, for an average of 2.7 weeks). However, when analyzing the subset of subjects with the highest IOP reduction (average of 36%), significant topographic changes were observed. It is apparent from the previous reports that topographic optic disc changes occurred more often in eyes with the greatest IOP reduction (normally ≥40%), although not consistently in every study. In our study, the observed IOP reduction between visits 4 and 5 (induced by resumption of medication) was lower, on the order 22% (average, 4.9 mm Hg), which can help explain why we did not observe any systematic change in optic disc topography induced by reduced IOP. Another possible difference between our study and those that observed topographic changes following trabeculectomy is that factors other than IOP reduction, such as subclinical optic disc edema after surgery, might influence optic disc topography and could take several months to subside.

Few studies have evaluated the effects of IOP elevation on optic disc topography and those that have been published looked only at the effects of acute IOP elevation. Azzurra-Blanco et al and Piette et al observed significant optic disc cup enlargement and decrease of rim parameters in normal and myopic eyes following a marked and acute IOP elevation induced by ophthalmodynamometry. These changes were reversible, returning to baseline levels within 2 minutes of normalization of IOP. To the best of our knowledge, our study is the first to evaluate topographic changes following sustained, moderate elevation of IOP during a few weeks in a group of patients with glaucoma. We failed to observe any systematic change in optic disc topography in these eyes, both in terms of stereometric parameters or discrete topographic locations. In some eyes, however, we observed topographic changes on the order of 5% to 10% compared with baseline, but these changes are likely within the expected measurement variability, since they also occurred in several of the control eyes with stable IOP. Moreover, we did not observe any relationship between changes in rim area and mean cup depth and the amount of IOP elevation.

Changes in optic disc surface and position of lamina cribrosa have also been observed following acute IOP manipulation in experimental animal studies in dogs and monkeys. Morgan et al showed optic disc surface and lamina cribrosa movement shortly following IOP elevation and/or with cerebrospinal fluid pressure elevation in dogs, demonstrating that the translaminal pressure gradient is important in determining the position of the structures of the optic nerve head. Bellezza et al have demonstrated both plastic (permanent) and transient (hypercompliant) posterior displacement of the lamina cribrosa in the monkey glaucoma model. Other studies from the same laboratory have elucidated the stress and strain induced by elevated IOP in different areas of the optic nerve head and peripapillary retina.

It is evident from our results, as well as from previous publications, that factors besides the magnitude of the IOP change might be important in determining topographic optic disc changes after IOP modulation in glaucomatous eyes. We could speculate that optic disc compliance, stage of optic disc damage, type of optic disc cupping, and age, among other factors, could be relevant. One of the factors that might be important to optic disc compliance is scleral or lamina cribrosa thickness. Unfortunately, there is currently no clinical method to measure posterior scleral thickness or lamina cribrosa thickness or compliance. Since the cornea and sclera form a continuous collagenous structure, it is logical to assume that the thickness of these 2 structures would be correlated, even though this correlation has not yet been demonstrated in human eyes. In this study, we decided to evaluate if CCT, as a possible surrogate in-
n the study population, we did have some examples where this appeared to be the case, but overall, the fluctuations observed in the study eyes were no different from what occurred in the control eyes, in which the IOPs were stable. The clinical implications of our findings are that HRT images obtained at different levels of IOP within the 20% to 30% range during follow-up can be used to assess progressive glaucomatous damage in most patients. Our results do not apply, however, to IOP changes of greater magnitude. They do not apply, either, to IOP reduction induced by glaucoma surgery, when probably factors other than just the IOP reduction might be relevant. In these circumstances it might be advisable to establish a new HRT baseline to evaluate optic disc progression with this technique.

Submitted for Publication: May 19, 2005; final revision received August 29, 2005; accepted September 12, 2005. Correspondence: Marcelo T. Nicolela, MD, Eye Care Centre, 1278 Tower Rd, Halifax, Nova Scotia, Canada B3H 2Y9 (nicolela@dal.ca).

Author Contributions: Dr Nicolela had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Funding/Support: This study was supported by a research grant from the Capital Health Research Fund. Financial Disclosure: None.

Previous Presentation: This study was presented at the Annual Meeting for the Association for Research in Vision and Ophthalmology: April 28, 2004; Fort Lauderdale, Fla.

REFERENCES