The Effect of IOP on Clinicians' Perceptions of Glaucomatous Optic Neuropathy

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Abstract

Background: *Clinicians' determination of glaucomatous optic neuropathy may be biased by other aspects of the case, including patient intraocular pressure (IOP).*

Methods: *Optic disc photos rated as glaucoma, normal or uncertain along with an IOP reading were shown to clinicians with various levels of experience. The clinicians were asked to label the photos as glaucomatous or normal. One month later, they were asked to re-evaluate the photos using the same or different IOP.*

Results: *Reclassification was extensive across all levels of clinician experience. Reclassification based on IOP change was greater for less experienced clinicians, who were also more likely to reclassify when IOP was decreased.*

Conclusions: *Less experienced clinicians may be more likely than those with more experience to change perceptions of glaucomatous optic neuropathy based on IOP. Training should be aimed at evaluating the optic nerve independent of other variables.*

Key Words: *glaucoma, optic nerve assessment, clinical education*

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Background

Evaluation of the optic nerve is essential to the diagnosis and management of glaucoma. However, the evaluation may be difficult based upon the particular disc. Assessment of the nerve is subjective, without well-established criteria of what constitutes glaucomatous optic neuropathy. Fundus photography and, more recently, imaging instruments such as OCT, HRT and GDX have been used to gather additional information to assist in evaluation of the disc and identifying and monitoring glaucomatous damage.

Intra- and inter-examiner variability in evaluating the optic nerve is well-documented.[1-3] Studies have shown this variability to be associated with profession, level of experience in managing glaucoma and practice setting.[4-8] Moreover, evaluation of the nerve may be contaminated by bias. Additional examination findings may influence the clinician's judgment in describing the nerve and whether it is labeled as glaucomatous or normal. Clinicians with less experience may be particularly likely to be influenced by factors other than the nerve itself. Thus, teaching non-biased optic nerve evaluation becomes a critical task for the optometric educator.

One potential source of bias that is associated with, but does not define, glaucoma is intraocular pressure (IOP). An optic nerve with a given high IOP may be more likely to be labeled as glaucomatous, while the same nerve with a lower IOP may be more likely to be labeled as normal. As glaucoma educators, in a pilot study, we examined whether the given IOP at the time of evaluation influenced clinicians' impression of whether or not a disc was glaucomatous and if this impression was associated with level of experience.

Methods

Twenty-six optic nerves of 26 patients seen at the Glaucoma Institute at SUNY College of Optometry were used. All patients had either the diagnosis of glaucoma or glaucoma suspect. Photos of the nerves were viewed on a non-stereo slide viewer. All of the photos were of good quality. Two experienced glaucoma clinicians (the

authors) classified the nerves as glaucomatous, non-glaucomatous or uncertain. When they agreed, the nerve was labeled as per their classification. If they disagreed, it was labeled as uncertain. **Figures 1a, 1b and 1c** show examples of nerves classified as glaucomatous, non-glaucomatous and uncertain.

Nine clinicians, whose clinical experience spanned a wide range, were asked to evaluate the optic nerves. The evaluators consisted of:

- one ophthalmologist who was fellowship-trained in glaucoma
- two optometrists within the Glaucoma service: one with more than 20 years' experience in managing glaucoma, one with less than 10 years' experience
- one optometrist in the Primary Care clinic, with 20 years' experience in general practice
- two optometric residents: one based in the Ocular Disease service (which includes the Glaucoma service), and one based in the Vision Therapy service
- two fourth-year optometry students in their final rotation
- one third-year optometry student who had recently completed the glaucoma course but who had little clinical experience in examining glaucoma patients.

The clinicians were asked to evaluate the optic nerves in two sessions. In session one, the clinicians were given the following instructions:

"I'm going to show you images of 26 optic nerves. I want you to classify them as either having glaucomatous optic neuropathy or not having glaucomatous optic neuropathy. This is a forced choice, so you must select Glaucoma or Normal. You should consider this your first time seeing the patient. The IOP at that visit is in the upper right corner of the image. I recognize that you are not viewing the images stereoscopically as you would clinically and that a forced choice of Glaucoma or Normal is not how you would function when seeing patients."

In session two, conducted one month later, the clinicians were given the same instructions. However, the IOP was changed for 20 of the 26 images, 10 upward and 10 downward. The magnitude of change was always greater than 6 mmHg and always enough to cause the IOP to go from being within the normotensive range to the high tension range or vice versa. The order of presentation of the nerves was also changed.

We evaluated whether classification was changed from one session to another for the nine clinicians and whether any reclassification was associated with a change in IOP. We defined an *IOP-influenced* reclassification as one in which the clinician changed from glaucoma to normal if the IOP at session two was lower or from normal to glaucoma if the IOP was higher.

Results

Of the 26 nerves, four were classified as glaucomatous, nine as normal and 13 as uncertain by the two original evaluators.

We divided the clinicians according to level of experience in treating glaucoma:

More experienced (4)

- fellowship-trained ophthalmologist
- two optometrists in the Glaucoma service
- optometrist in the Primary Care clinic

Less experienced (5)

- two optometric residents
- two fourth-year optometry students
- one third-year optometry student.

Figure 1
a: An Optic Nerve Classified as Glaucomatous b: An Optic Nerve Classified as Non-Glaucomatous
c: An Optic Nerve Classified as Uncertain

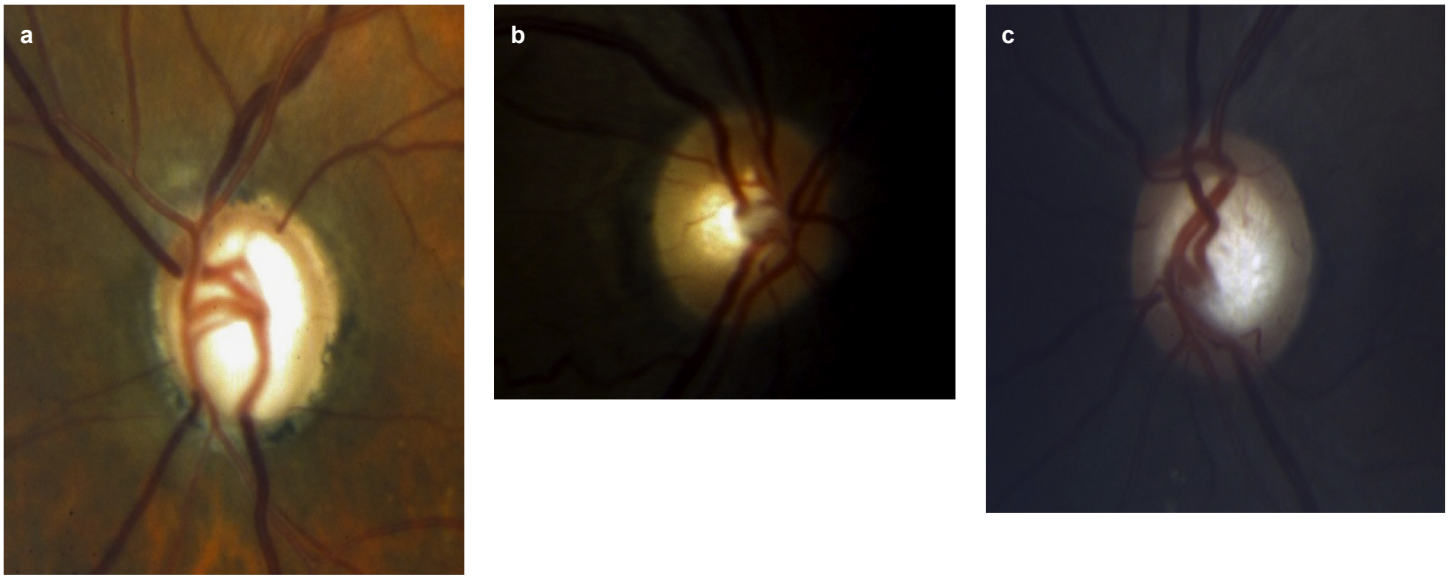


Figure 2 shows the number of changed classifications for each clinician. For the 26 nerves, the number of reclassifications ranged from 4-13, with an average of 8.7. Reclassifications were spread across the range of clinician levels of experience. The more experienced clinicians made an average of 7.75 reclassifications, while the less experienced made an average of 9.60. The difference was not statistically significant.

Figure 3 shows the percentage of reclassifications by clinician for glaucomatous, normal and uncertain nerves. It shows that reclassification was pervasive across all categories without a clear trend for one type of nerve in terms of reclassification.

In total, reclassifications were not greater when the IOP was changed than when it was not. However, as shown in **Figure 4**, there was a greater percentage of IOP-influenced reversals for the less experienced clinicians as compared to the more experienced clinicians.

Figure 5 illustrates clinicians' change in classifications for the 13 discs labeled as uncertain when the IOP was increased, decreased and remained the same. Taken as a whole, the data do not show a clear trend by clinician type or impact of IOP change on reclassification of these discs.

Figure 6 shows reclassifications in uncertain discs with respect to change in IOP for the most and least experienced clinicians. It shows that there is little difference between the two in reclassifications when IOP is the same or increased. However, there is a large difference between the groups when IOP is decreased. Less experienced clinicians differed from the more experienced in reclassifying from glaucoma to normal when the IOP is decreased but not from normal to glaucoma when the IOP is increased.

Discussion

One of the challenges in educating the developing optometric clinician is in teaching him or her how to properly evaluate ocular structures. An accurate, consistent evaluation of the optic nerve is important not only in glaucoma diagnosis and treatment but also in working in an environment in which more than one clinician may examine the pa-

Figure 2
Number of Changed Classifications by Clinician (n=26 nerves)

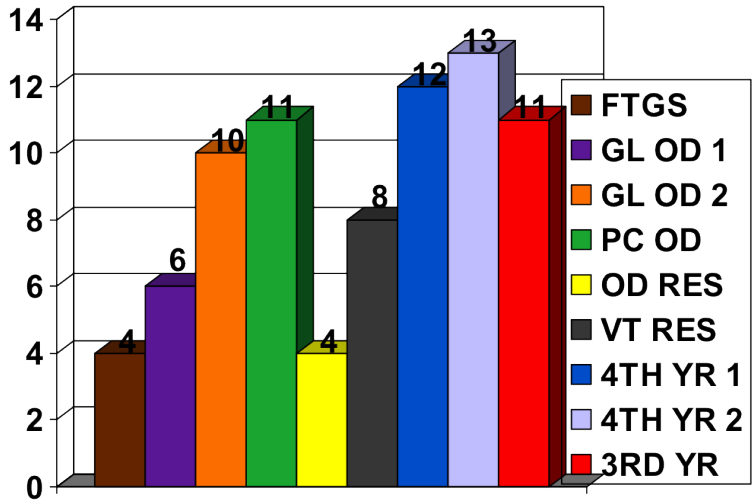


Figure 3
Percent Changed Classifications per Clinician for Normal, Glaucomatous and Uncertain Nerves

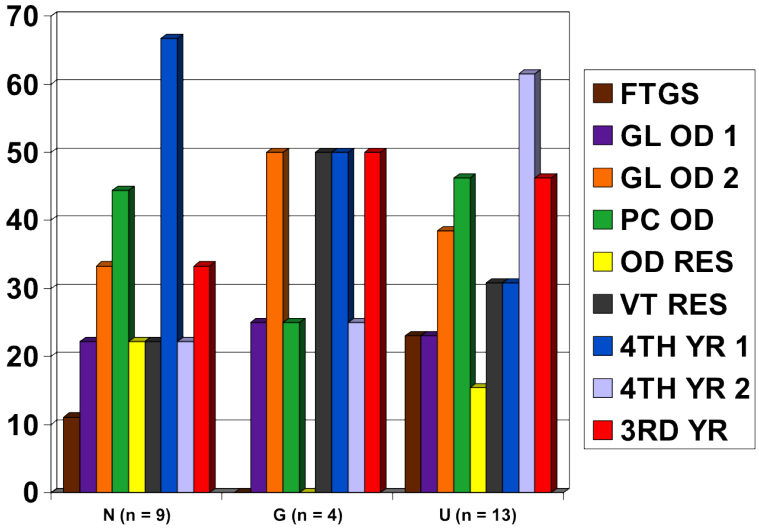
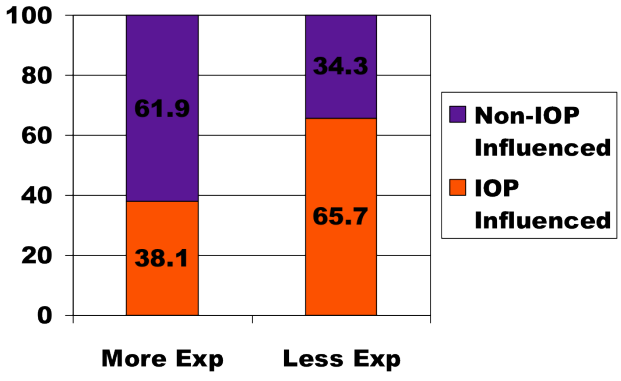


Figure 4
Percent of IOP-Influenced Changed Classifications By Clinician Experience



tient over time. In line with our investigation, other studies have examined variability in evaluating the optic nerve head among those with different levels of training.

Spalding,[6] in an evaluation of 56 optometrists, showed that there tended to be more inter-observer agreement in estimating cup-to-disc ratios and perception of glaucomatous damage in optometrists who were residency-trained, had more glaucoma patient encounters, and who did not practice in commercial settings. In a study across professions, Harper found a higher level of agreement in disc evaluation between the more experienced optometrists and ophthalmologists than between those with less experience.[5]

In a study similar to the present study, Hanson[7] and colleagues investigated subjects that included third- and fourth-year optometry students as well as optometrists who estimated cup-to-disc ratios based on photographs. They found that inter-observer but not intra-observer agreement increased with level of experience. The authors speculate this is because observers come to adopt similar criteria for making the assessment. They suggest that if we adopt a common method for evaluating optic nerve parameters during training, it may be useful in reducing variability.

In the present study, we evaluated intra-observer variability with respect to level of experience, but added a unique feature. We altered the intraocular pressure to see what influence this had on the clinician opinion of labeling an optic nerve glaucomatous. Our clinicians represented a wide variety of experience from fellowship-trained glaucoma specialist to third-year optometry student.

Our data show a relatively large number of changed classifications. In total, approximately one-third of the classifications were changed in part two of the study. Overall, there was a general trend to fewer reversals with more experience, but there was wide variability in the data. Of the nine clinicians, the two with the least number of changes were the fellowship-trained ophthalmologist and one of the two residents. Another resident had fewer reclassifications than the more experienced doctors. There was not a significant difference in re-

Figure 5
Percent of IOP-Influenced Change in Classification for Uncertain Nerves

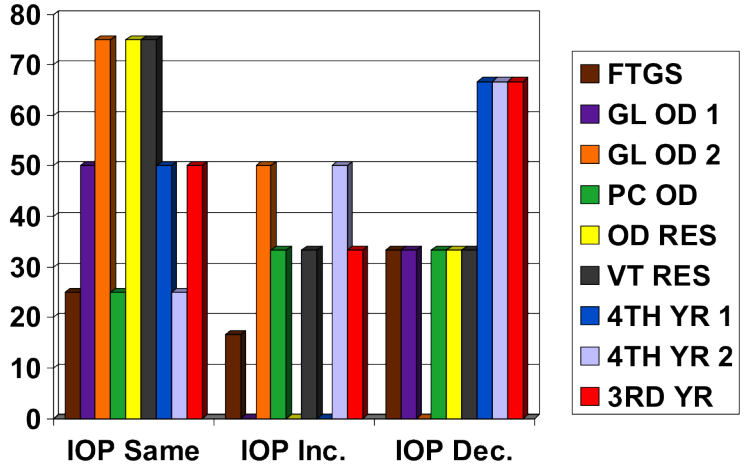
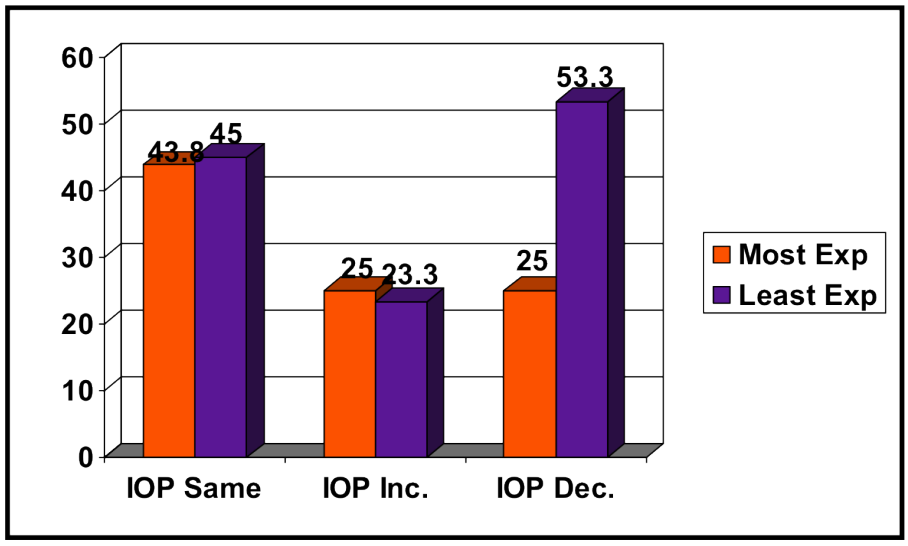


Figure 6
Percent of IOP-Influenced Change in Classification of Uncertain Nerves by Clinician Experience



classification when the nerve was labeled normal, glaucoma or uncertain.

In examining the influence of IOP on reclassifications, we found that the reversals for the less experienced group were more likely to be associated with IOP change than they were for the more experienced group.

Perhaps the most unique finding of our study was that with respect to nerves labeled as uncertain, an IOP decrease was more likely to be associated with a reclassification than an increase in the group with less experience. This implies that the less experienced clinicians are more likely to label a disc normal with high IOP, in effect diagnosing ocular hypertension, than to label a disc with a lower IOP as glaucomatous. It is thus possible that normotensive glaucoma patients may be undiagnosed.

Establishing more standardized ways of evaluating the optic nerve may provide a more accurate assessment of the nerve and reduce bias. Educating students and residents may help bridge the gap between more and less experienced clinicians.

A number of studies have looked at the impact of training on this. Breusegem[9] compared experts and non-experts in evaluating glaucomatous disc changes using serial stereo photographs. Agreement of non-experts was significantly lower than that of experts, which was moderate. After training the non-experts, the inter-observer agreement and accuracy of the non-experts showed a small but statistically significant improvement.

Sheen[10] and colleagues evaluated differences between student and expert observers. They showed students stereo discs and compared their evaluations to those of experts before and after a stereo teaching program. Following the program, the two groups of observers showed a greater correlation in their evaluations than before.

The above studies indicate that training may reduce optic disc evaluation differences between more and less trained clinicians. But they do not address the issue of how this assessment is affected by accompanying findings such as IOP. Our data suggest that there is significant variability in all subjects' impressions of the same optic nerves, but that the level of IOP may play a greater role in affecting the impressions of clinicians with less experience.

While there is certainly educational benefit to teaching the case in a holistic fashion, students may be biased in their evaluation of one aspect of the case that is independent of others. Glaucoma educators should work to insure that their students recognize that glaucomatous optic neuropathy is an independent finding and that its evaluation should not be biased by others that accompany it. Our data suggest that, to the extent possible, clinical teaching of optic nerve evaluation be done independently from knowledge of the IOP.

There are limitations to our study. One noteworthy one is the small sample size of subjects. Although there were nine clinicians, there were only a few in each level of experience. For example, there were only two residents, each giving very different responses as to their changes in classification. There was only one fellowship-trained glaucoma clinician and only one third-year student. We grouped the subjects into the four with the most and the five with the least experience, but in doing so more specific information for level of experience may have been masked.

Another limitation is that the evaluations were conducted using non-stereoscopic viewing conditions. It is recognized that this is not the most reliable way to evaluate the nerve. Perhaps if we had used stereoscopic conditions there would have been less variability. Additionally, a magnified version of the optic discs was presented, without the surrounding retinal area. This made it easier for the evaluator to observe details on the disc but not size cues that would have provided more information for determining whether or not the disc was glaucomatous.

Additionally, the number of nerves across the three categories of normal, glaucomatous and uncertain was not the same. There were four glaucomatous nerves, nine normal and 13 uncertain. Thus, there was significant disagreement on the part of the two classifiers as to whether or not the nerves were glaucomatous. This made a robust statistical analysis of the three categories difficult. The comparatively low number of glaucomatous nerves made it difficult to differentiate how subjects responded to each classification. This difficulty was increased by the fact that there were only two original classifiers without substantial agreement between them on the nerves. Half the nerves were deemed uncertain and this may have increased the number of reclassifications and variability among the clinicians. Building upon this pilot study, a future investigation could yield more robust results by limiting classification of nerves into only normal or abnormal categories and increasing both the number of nerves and evaluators.

Conclusion

Lowering the intraocular pressure was associated with increased reclassifications from glaucomatous to normal optic discs among less experienced evaluators. However, even without IOP change, there was considerable variability among all categories of clinicians. This made it more difficult to determine how much variability was due to IOP change and how much was independent of IOP change. It may be that evaluation of the optic nerve for glaucoma by looking at slides is an inherently subjective and variable process. It is important that educators take into account potential biases in training students to evaluate the optic disc.

Our study suggests the need for more standardized parameters in evaluating the optic nerve for glaucoma. A noteworthy one is the cup to disc ratio. Others include the size of the disc, health of the rim tissue, whether the nerve obeys the ISNT rule, abnormalities in the rim vasculature, the presence of disc hemorrhage, and the existence of a beta zone of peripapillary atrophy. A methodological approach including these elements should be incorporated into clinical training.

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