

**Clinical Comparison of Intraocular Pressure Measurements Using  
Goldmann and Proview™ Tonometry**

**By:**

**Joy A. Kerns, B.S., and Ann K. Bar, B.S.**  
*Michigan College of Optometry*

**Faculty Advisor:**  
**Fred Nista, O.D.**



**Background:** The Proview tonometer (Bausch & Lomb, Rochester, NY), the new pressure phosphene tonometer, would allow glaucoma patients to monitor intraocular pressure (IOP) by themselves and at various times of the day. The diurnal variation in one's IOP that is known to exist can play an important role in the management of glaucoma. Unfortunately, there has never been an efficient way to self-monitor IOP. However, the Proview tonometer, if proven an accurate means of IOP measurement, would provide doctors insight into the patients diurnal variations and allow for the most appropriate medical management of the disease.

**Methods:** A total of 50 non-glaucoma patients (100 eyes) were measured over a 4-week period. Each subject was thoroughly instructed on the use of the Proview Tonometer by an examiner. The subject was then allowed to "practice" seeing the pressure phosphene by using their finger in place of the Proview Tonometer. After each subject acknowledged to a complete understanding of the procedure, they were to perform Proview tonometry on themselves, with one reading being taken on each eye. The same examiner who gave the instructions recorded the IOP measurements. Goldmann tonometry was then performed one time on each eye of every subject. This was done by a different examiner and the results recorded. There was no communication between the different examiners regarding the results of each method.

**Results:** 15% of the measurements were within  $\pm 1$ mmHg, 35% of the measurements were within  $\pm 2$ mmHg, and 37% of the measurements differed by 5mmHg or more. The average difference between readings for all of the measurements was 4.05mmHg. For Proview tonometry, the mean IOP was 15.12mmHg with a standard deviation of 3.86 and a range of 19mmHg (8-27mmHg). With Goldmann, the mean was 15.35mmHg with a standard deviation of 3.18 and a range of 14mmHg (9-23mmHg). The t test for paired data showed a P value of 0.64 with a correlation coefficient of 0.017.

**Conclusions:** IOP measurements taken by the test subject with the Proview tonometer did not correlate with measurements taken with Goldmann tonometry. This suggests that Proview tonometry does not prove to be an accurate alternative method for measuring IOP when the subject is taking the measurement. One of the main proposed uses of the Proview tonometer is self-administered home testing of IOP. However, this potential use may provide inaccurate information regarding IOP measurements due to the poor correlation with Goldmann.

**Key Words:** Proview tonometer, Goldmann tonometer, Intraocular pressure, glaucoma, diurnal variation, pressure phosphene



## **Introduction**

Phosphene tonometry is a new method of measuring intraocular pressure based on the natural phenomenon of pressure phosphenes generated by the retina. The purpose of this article is to compare the new phosphene tonometer to Goldmann tonometry. Goldmann applanation tonometry is widely accepted as the gold standard for clinical assessment of intraocular pressure.<sup>1</sup> Phosphene tonometry has the potential to be a very valuable tool in the management of open angle glaucoma, which affects an estimated 2.91 million Americans.<sup>2</sup> Open angle glaucoma, or OAG, is a disease that will lead to blindness if left untreated. One article reported that in the year 2000, 130,540 people in the United States would be blind from primary glaucoma.<sup>2</sup>

Phosphenes are entoptic phenomena that appear as luminous sensations produced by non-light stimuli. The word *phosphene* comes from the Greek word meaning "to show light".<sup>3</sup> The Proview® tonometer relies on a certain type of phosphene produced when mechanical pressure is applied to the eye. When gentle and slowly increasing pressure is directed at the nasal or temporal aspect of the eye, a blue-white ring of light appears in the opposite portion of the visual field. For example, pressure at the nasal area produces the sensation of light in the temporal visual field. This ring of light has been called Purkinje's Blue Ring of Gentle Pressure.<sup>3</sup> It is thought to arise from direct sensory effect at the sensory retinal elements.

It is well known that all patients have diurnal variations in intraocular pressure. The causes of the cyclic variation in IOP are postulated to be mechanisms of resistance to the drainage of and also the formation of aqueous humor.<sup>4</sup> The characteristic pattern of this variation is: higher IOP in the morning, decreasing IOP as afternoon approaches and a tendency to rise again later in the afternoon. A recent study reported that among patients with open angle glaucoma, normal tension glaucoma and normal patients, the largest fluctuations were measured in the group of OAG patients. The subjects with the lowest range of intraocular pressure were in the normal patient group.<sup>5</sup> For some patients, these rhythmical changes are well tolerated but for others, they can have serious effects. Patients who show a progression of visual field defects are more likely to have peaks of IOP compared to those whose visual fields remain stable.<sup>4</sup> Alpar reported in a study using self-tonometry, that patients who had IOP 4-13mmHg greater than what was measured during office hours developed glaucomatous damage.<sup>4</sup> A large scale study in Japan showed that the percentage of glaucomatous visual field defect starts to increase as IOP rises above 15mmHg.<sup>6</sup>

Since there is no guarantee of how much an individual's pressure varies throughout the day, one can only assume that a specific patient being treated for OAG falls in the normal distribution of pressure ranges. It is not feasible to have a patient hospitalized to measure his pressure every hour for 24 hours in order to establish a personalized diurnal curve. Unfortunately, erratic and morning curves are present in 43% of OAG patients. These curves yield IOP peaks outside of normal office hours.<sup>7</sup> However, if the patient had some way of measuring IOP at home, it would provide the doctor with much insight into the individual's range of intraocular pressure. This would affect the medical management of glaucoma and provide a better target pressure to be maintained via drug therapy. The Proview® tonometer, developed by Bausch & Lomb, is designed to be used at home by patients who can keep a log of their normal variations in intraocular pressure.

## **Methods**

The Proview tonometer (Bausch & Lomb, Rochester, NY) is a small, handheld, plastic device measuring approximately 4½ inches long. It has a compressible spring that corresponds to a scale printed on the device by the manufacturer. The scale reads in millimeters, ranging from 8 to 40mm. The end of the probe has a round, flat plate which is applied to the nasal portion of the closed eyelid without using anesthetic. The patient applies gentle pressure with the tonometer against the lid until the pressure



phosphene is seen, and then the tonometer is removed from the eye. The measurement is read by the patient and recorded in mmHg. The tonometer is reset by simply pressing down a plunger at the end opposite the probe.

This study was approved by the Human Subjects Review Committee at Ferris State University. 50 subjects participated in the study, and 100 eyes were tested. No subjects had previously been diagnosed with glaucoma. After each patient signed a consent form and had an opportunity to ask questions, the procedure was carefully explained and then the patient was asked to perform phosphene tonometry on him or herself. Each was instructed to look down toward the same side of the body as the eye being tested. For example, if the right eye was being measured, the patient looked down toward her right side. Then each participant used an index finger to stimulate a pressure phosphene to generate an awareness of what to expect when using the tonometer. After each patient felt comfortable, he or she was given the Proview tonometer and asked to measure his or her own intraocular pressure. Once the pressure phosphene was detected, one of the researchers took the instrument and recorded the reading indicated on the side of the tonometer. The results were recorded after the first measurement was taken. No participant was given a second chance to re-measure his or her IOP. The participant proceeded to have Goldmann tonometry performed by the other researcher involved in the study, who was unaware of the results yielded by the phosphene tonometer. Goldmann tonometry required that one drop of Fluress® be instilled into each of the participants. This solution is composed of the anesthetic benoxinate hydrochloride 0.4% combined with the ophthalmic dye, fluorescein sodium 0.25%. It also has 1% chlorobutanol acting as the preservative. All study participants were aware of the small risks associated with Fluress, including transient irritation of the cornea and conjunctiva. Once data had been collected on 100 eyes, it was analyzed for a correlation between intraocular pressure measurements taken with the Proview tonometer and the standard method of Goldmann tonometry.

### **Results**

The information from all 100 eyes was able to be used. The data obtained was statistically analyzed using a paired t-test. The mean IOP using Proview tonometry was 15.12 mmHg with a standard deviation of 3.86. The measurements ranged from 8-27 mmHg. The mean IOP using Goldmann tonometry was 15.35 mmHg with a standard deviation of 3.18. The measurements ranged from 9-23 mmHg. By comparing the results based on mean IOP and standard deviation only, there does appear to be some correlation between the two methods of measurement. However, the t-test showed a p value of 0.64 and a correlation coefficient of 0.017. Figure one illustrates differences between IOP measurements and the frequency that the difference occurred. 15% of the measurements were within +/- 1 mmHg. 35% of the measurements were within +/- 2 mmHg. 37% of the measurements differed by 5 mmHg or more. The average difference between readings for all of the measurements was 4.05 mmHg.

### **Discussion**

The data suggests that there is no correlation between the IOP measurements taken with the Proview tonometer and the gold standard Goldmann tonometer. This conclusion is supported with the results of a paired t-test that provided a p value of 0.64 and a correlation coefficient of 0.017. In a clinical study comparing the two methods of IOP, Bernard B. Fresco, MSc, OD suggested that there is close agreement between IOPs taken with both Goldmann and Proview tonometry.<sup>8</sup> However, in that study, Proview tonometry was performed by an examiner and not by the test subject. Due to the fact that the Proview was designed for patient self-administration, the results of that study do not seem to be clinically relevant. In our study, each subject was thoroughly educated on the technique necessary to obtain an IOP reading with the Proview tonometer and then allowed to measure their own IOP. What our study did not do was provide subjects with extensive periods of time to become acquainted with the instrument. While other clinical studies are currently underway that do allow the patient to spend a significant amount of time with the Proview before using the measurements in the data, there has been no confirmed evidence that



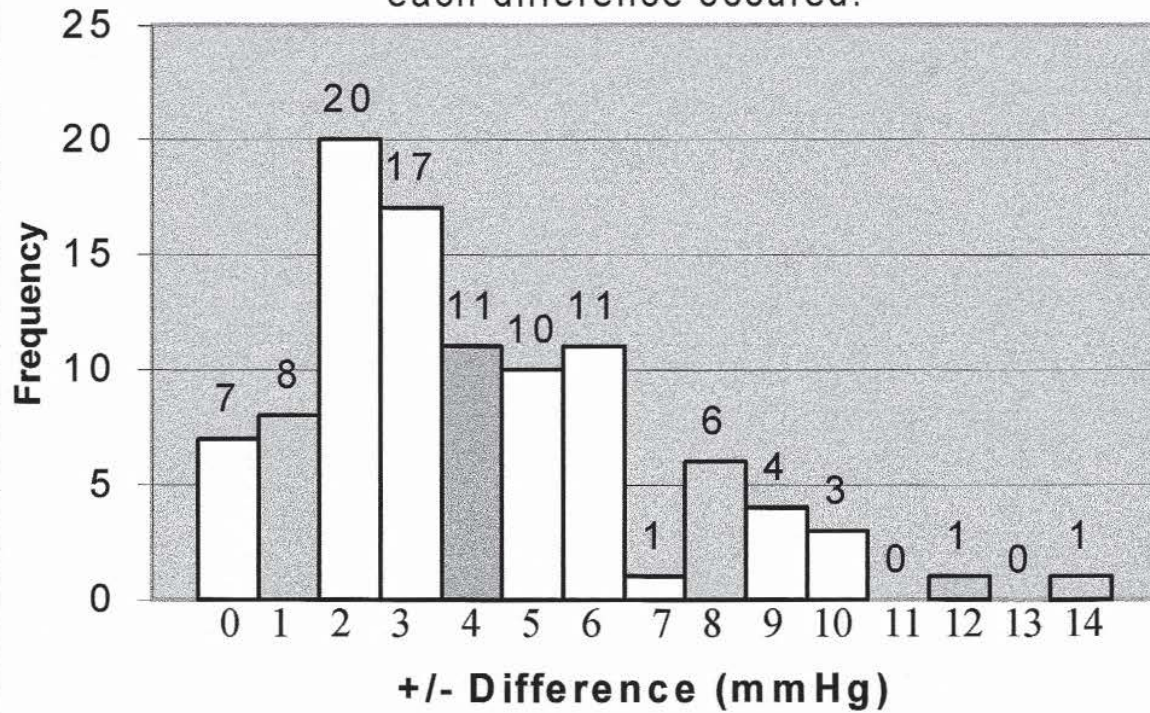
the Proview is an acceptable substitute for Goldmann. Practitioners that are using this new instrumentation to home monitor IOP diurnal variations in their glaucoma patients may want to think twice before determining medical intervention based on the readings taken with the Proview.

#### **Acknowledgments**

We would like to thank Dr. Fred Nista O.D., Professor at the Michigan College of Optometry and our research advisor, for all of his help and support. We would also like to thank Dr. Michael Cron, O.D., Professor at the Michigan College of Optometry, for providing his expertise in statistical analysis.



Figure 1. Differences between IOP measurements taken with Proview and Goldmann Tonometry and the frequency that each difference occurred.





## References

1. Sudesh S, et al. Accuracy of Goldmann tonometry in clinical practice. *Acta Ophthalmologica*. 1993;71:185-188.
2. Quigley H, Vitale S. Models of open-angle glaucoma prevalence and incidence in the United States. *Investigative Ophthalmology and Visual Science*. Jan 1997; 38(1): 83-90.
3. Duane, Thomas D. Biomedical foundations of Ophthalmology. *Entoptic Imagery and After Images*. (2)20 p 9-11. 1986.
4. Gonzalez I. et al. Assessment of diurnal tensional curve in early glaucoma damage. *International Ophthalmology*. 1997;20:113-115.
5. Saccá S. et al. Fluctuations of Intraocular pressure during the day in open-angle glaucoma, normal-tension glaucoma and normal subjects. *Ophthalmologica*. 1998;212:115-119.
6. Yamagami J. et al. Diurnal variation in intraocular pressure of normal tension glaucoma eyes. *Ophthalmology*. May 1993;100(5):643-649.
7. Wilensky J. et al. Individual variability in the diurnal intraocular pressure curve. *Ophthalmology*. June 1993;100(6):940-944.
8. Fresco, Bernard B. New Tonometer—The Pressure Phosphene Tonometer. Clinical Comparison with Goldmann Tonometry. *Ophthalmology*. November 1998; 105(11):2123-2126.