

**A comparison of the Reichert PT-100 hand held, non-contact
tonometer to Goldmann and Tono-Pen tonometers**

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Abstract

The purpose of this study was to determine the accuracy, and ease of use of the new Reichert PT-100 hand held, non-contact tonometer in measuring intraocular pressure (IOP). The accuracy was determined by comparing the results of the hand held tonometer to the "gold standard", Goldmann tonometer and then to the current hand held standard, the Tono-Pen. The ease of use was assessed by subjective evaluations from the two individual 4th year optometric interns involved in this study. Data was collected from 75 subjects (non-clinical population) using these three tonometers: the Reichert PT-100 hand held, non-contact tonometer, Goldmann tonometry, and the Mentor Tono-Pen XL.

Introduction

Glaucoma is one of the leading causes of blindness in both the United States and worldwide (1). It is stated that 2.5 million people have glaucoma in the U.S. alone and more than 130,000 are legally blind from it (1). Also discussed is the higher incidence of ocular damage from glaucoma in those of African-American decent, those with cardio-vascular disease and the elderly. Glaucoma is diagnosed based on many factors including intraocular pressures (IOP), optic nerve cupping, corneal thickness, and visual field changes (1). Also stated is the significant amount of the population with undetected high intra-ocular pressure, those individuals with a high degree of daily variation in their IOP, and/or those who lose visual function because of glaucoma even with normal IOP's (1,2). Therefore, to be thorough in one's differential diagnosis of potential glaucoma, it is imperative to be able to detect these IOP changes in order to prevent any damage to the optic nerve and avoid visual field loss.

The "Gold Standard" method for measuring IOP is Goldmann tonometry (3). It involves applanation of the cornea and is based on equilibrium between the applanation force and ocular tissue. In one study, when taking three measurements, the IOP's only varied by 6 percent (4). Over time, different style tonometers were developed to substitute for Goldmann. Some of these tonometers were even portable, as compared to Goldmann, which is affixed to a slit lamp (biomicroscope). In the past the Schiötz and the Perkins tonometers were the portable or handheld favorites (5). More recently one of the most popular portable tonometers is the Tono-Pen XL. It uses electronic signals and takes four measurements from the corneal surface to generate the mean IOP reading (3).

Several studies show that the Tono-Pen is comparable to Goldmann (3,6). In one study, the Tono-Pen showed an IOP difference of $< 3\text{mmHg}$ in 77% of the cases (3). However, it was shown that when the IOP was $> 24\text{mmHg}$ as measured by Goldmann, the Tono-Pen generally underestimated the IOP (3). The Tono-Pen is still widely used by many practitioners as a valid technique to measure IOP's, and due to its portability, is a great asset for glaucoma screenings, hospital and nursing home visits, wheel chair bound and/or special needs populations.

Yet another method for measuring IOP has been developed in which no direct applanation of the cornea is involved. Generally, this technique is used by measuring the air pressure required to flatten an area of cornea and then extrapolating the IOP (7). There are several different instruments that use this mechanism of measuring IOP, the most common being the Non-Contact Tonometer or NCT (8). This study showed the comparison of the NCT to the Goldmann. These two commonly used tonometers were comparable (within 3 mm) within the average (10 to 20 mm) range, but the NCT tended to over-estimate the IOP when pressures were above 20 mm. One of the newest instruments available is the Reichert PT-100 hand held non-contact tonometer (7). This unit uses a quiet, soft puff of air on the cornea to read the IOP's. The PT-100 has its advantages of being portable, unlike Goldmann, and being non-contact, unlike the Tono-Pen. However, the PT-100 IOP measurements need to be established against some proven instrumentation of IOP measurement.

The purpose of this paper will be to determine the accuracy, and ease of use of the new Reichert PT-100 hand held, non-contact tonometer, as compared to Goldmann tonometry and the Tono-Pen XL. The validity will be established by its comparison to the Goldmann tensions on each individual subject.

Methods

Data was compiled from 75 subjects (n=75) for this study. Subjects were students, faculty, and staff of the Michigan College of Optometry (MCO), at Ferris State University. All of the subjects were asked to sign a consent form prior to participating (appendix A). The examiners performing this study were two fourth-year optometry student interns. Three tonometric procedures were performed in random order on each of the subjects. The tonometry measurements were determined using three different instruments: the Goldmann applanation tonometer, the Mentor Tono-Pen XL, and the new Reichert PT-100 hand held, non-contact tonometer. A computer-generated program randomized the sequence of the procedures in order to keep the data random. The two examiners familiarized themselves with the instruments prior to beginning the study. This allowed the examiners to compare the measurements on all three instruments to assure that the data was accurate (reliable and comparable) with either of the two examiners performing the measurements.

The intraocular pressure (IOP) was measured according to published instructions for each individual tonometer on 75 subjects, 150 eyes. Prior to all three procedures, a slit lamp exam was performed on all subjects to rule out any corneal dystrophies or overt abnormalities. Also, subjects who had an allergy to the anesthetic were excluded from this study. Flurox was administered prior to all three procedures so that all of the readings were performed on the anesthetized eye. One examiner performed the procedure while the other examiner recorded the results of the measurements. The examiner performing the procedure did not know the results of the measurements in order to obtain accurate and reliable data. The recording examiner recorded each measurement on a different piece of paper, each one corresponding to one of the tonometers.

The three results were stapled together and collected and stored along with the other data. After all of the data had been collected, each group of measurements were assigned a random number and compiled on a table for comparison of the results using the paired t-test. All of the instrumentation that was used for this study is currently housed at the Michigan College of Optometry (MCO), and is used routinely in its various clinics.

Results

The mean and standard deviation of intraocular pressure measurements (IOP's) using each of the three tonometers is found on Table 1.

The determination of accuracy of the Reichert PT-100 hand held tonometer was based on measurements within ± 3 mmHg of the gold standard tonometer, the Goldmann tonometer, as well as that of the Tono-Pen XL. Intraocular pressure measurements were taken on both the right and left eyes of 75 individuals (150 eyes total) using all three tonometers.

It was found that compared to the Goldmann tonometer, the PT-100 hand held tonometer measured an IOP difference of ± 3 mmHg in 78% of the cases, 81% in the right eye and 74.6% in the left eye. The average IOP difference between the PT-100 and the Goldmann tonometers were 4.29 mmHg in the right eye and 2.31 mmHg in the left eyes of the 75 individuals measured.

The PT-100 hand held tonometer did not compare as accurately to the Tono-Pen XL as it did to the Goldmann tonometer. The PT-100 measured an IOP difference of ± 3 mmHg in 74.6% of the cases, 76% in the right eye and 73.3% in the left eye. Yet the average difference between the PT-100 and the Tono-Pen XL measurements were 2.25 mmHg in the right eyes and 2.52 mmHg in the left eyes of the 75 individuals measured.

Discussion

The purpose of this study was to determine the accuracy, and ease of use of the new Reichert PT-100 hand held non-contact tonometer in measuring intra-ocular pressure

The accuracy of the PT-100 hand held tonometer was determined by standards of being within 3 mmHg of the gold standard Goldmann tonometer, as well as the current hand held standard, the Tono-Pen XL. The data showed that the PT-100 tonometer measured IOP within 3 mmHg of the Goldmann tonometer 78% of the time, 81% with right eyes and 74.6% with left eyes. Compared to the Tono-Pen XL tonometer, the PT-100 measured IOP within 3 mmHg 74.6% of the time, 76% with the right eyes and 73.3% with the left eyes. The accuracy rates were higher for the right eyes than for the left eyes. The overall accuracy rates were average, leaving room for improvement for hand held tonometers.

Ease of use of the new Reichert PT-100 non-contact, hand held tonometer was a subjective measurement. A quick tutorial before use was helpful, but repetition was the best way to learn and become proficient, like with most new instrumentation. Overall, once taught how to use the tonometer, measurements went smoothly. The tonometer was lightweight, but rather bulky. Dimmer lighting was required/helpful to see the targets for accurate alignment. Since the PT-100 is an automatic puff, unless it was perfectly aligned, it would not fire. Anesthetic was not required so the measurement can be quick and easy for the most patients.

Overall, it simply took some time to adapt to using the PT-100 hand held tonometer and it would be a good tonometer to use for vision screenings, children, and handicapped individuals who have difficulty getting behind the slit lamp. However, it should not replace such instruments as Goldmann or Tono-Pen XL tonometers until more accurate measurements could be obtained by the PT-100 tonometer.

Conclusions

The purpose of this study was to determine accuracy, and ease of use of the new Reichert PT-100 non-contact, hand held tonometer in measuring IOP.

The PT-100 was proven accurate within ± 3 mmHg of Goldmann tonometry 78% of the time, 81% with right eyes and 74.6% with left eyes. The average difference was 4.29 mmHg for right eyes, and 2.31mmHg for left eyes. Compared to Tono-Pen, the PT-100 was within ± 3 mmHg 74.6% of the time for right eyes, and 76% of the time for left eyes. The average difference was 2.25 mmHg in the right eyes, and 2.52 mmHg for left eyes.

The PT-100 was a very portable tonometer, being lightweight and easy to transport. It could be used in any environment and would be a good tonometer to take on screening missions. Anyone could be taught to use this instrument, but there were some limiting factors such as lighting conditions, and simply learning how to adjust movements in order to get the tonometer to fire the puff.

In conclusion, this tonometer was shown to be accurate $> 75\%$ of the time, on average, and was very portable. The PT-100 would be beneficial for such purposes as vision screenings, or IOP measurements on children and handicapped individuals. However, it is not as accurate when compared to Goldmann or Tono-Pen XL tonometers, and therefore should not be used in place of these methods for routine eye care situations.

- Procedures followed for testing in this study were in accordance with the ethical standards of the Human Subjects Committee at Ferris State University and with the Helsinki Declaration of 1975, as revised in 1983.

Bibliography

1. Kass MA, Heuer DK, et al. The Ocular Hypertension Treatment Study (OHTS). *Arch Ophthalmol*. 2002; 120:701-713.
2. Ishikawa K, Tanino T, Ohtake Y, Kimura I, Miyata H, Mashima Y. A comparison of visual field and optic disc appearance depending on the peak intraocular pressure in patients with normal-tension glaucoma. *Nippon Ganka Gakkai Zasshi*. 2003 Aug;107(8):433-9.
3. Iester M, Mermoud M, Achache F, Roy S. New Tono-Pen XL: comparison with the Goldmann tonometer. *Eye*. 2001; Feb;15(Pt 1): 52-58.
4. Dielemans I, Vingerling JR, Hofman A, Grobbee DE, de Jong PT. Reliability of intraocular pressure measurement with the Goldmann applanation tonometer in epidemiological studies. *Graefes Arch Clin Exp Ophthalmol*. 1994; Mar;232(3): 141-144.
5. Whitacre MM, Emig M, Hassanein K. The effect of Perkins, Tono- Pen, and Schiotz tonometry on intraocular pressure. *Am J Ophthalmol*. 1991 Jan 15;111(1): 59-64.
6. Wingert TA, Bassi CJ, McAlister WH, Galanis JC. Clinical evaluation of five portable tonometers. *J Am Optom Assoc*. 1995; 66(11): 670-674.
7. Tonometry on the Move: The Reichert PT 100 Portable NCT. *Optician*. 2002; No. 5878, Vol. 224.
8. Moreno-Montanes J, Gomez-Demmel E, Lajara-Blesa J, Aliseda-Perez de Madrid. Comparative study of three non-contact tonometers and the Goldmann tonometer. *Ophthalmologica*. 1994;208(3):115-8.

Appendix A

Senior Project Volunteer Consent Form

Ashleigh and Shannon are doing a senior project determining the accuracy and reliability of the new Reichert PT-100 hand held tonometer by comparing the results of the hand held tonometer to Goldmann tonometry as well as to the Tonopen. We will need 100 participants in order to complete this study, and we are asking for 100% participation from all 3 years. A sign up sheet with times will be available in each classroom, if these times do not work for you, we will make arrangements to come in at your convenience, including weekends. The three procedures will take a total of five minutes. Please sign up for a time that is most convenient for you. We will be using room 529, which is right next to the VT room. Clinic attire is NOT required. Anesthetic will be installed prior to performing Goldmann and the Tonopen. A follow up exam will be made available for anyone experiencing any complications following the procedure. Please sign this consent form and return it to **Mailbox #14**. Thank you for your participation!!!!

I _____ freely volunteer to participate in the research project mentioned above. This research project has been explained to me and I understand the procedures to be followed, the estimation of my time commitment and any foreseeable risks, discomforts or benefits of the research. I understand that my privacy will be protected to the maximum extent allowable by law. I further understand that the results of this study may be published and if published, that I will not be individually identified in any way. I may also withdraw from this study at any time. I understand that my participation, lack of participation, or withdrawal from the study will not affect my status as a student in any way. If I have questions about the study or about being a participant in the study I may contact the principal investigators: Ashleigh Coss or Shannon Stanek at (231) 796 4716, or Dr. Wrubel at (231) 591 2193.

I fully understand the above and give my consent to serve as a participant in this study.

___ I am at least 18 years of age

Participant Signature

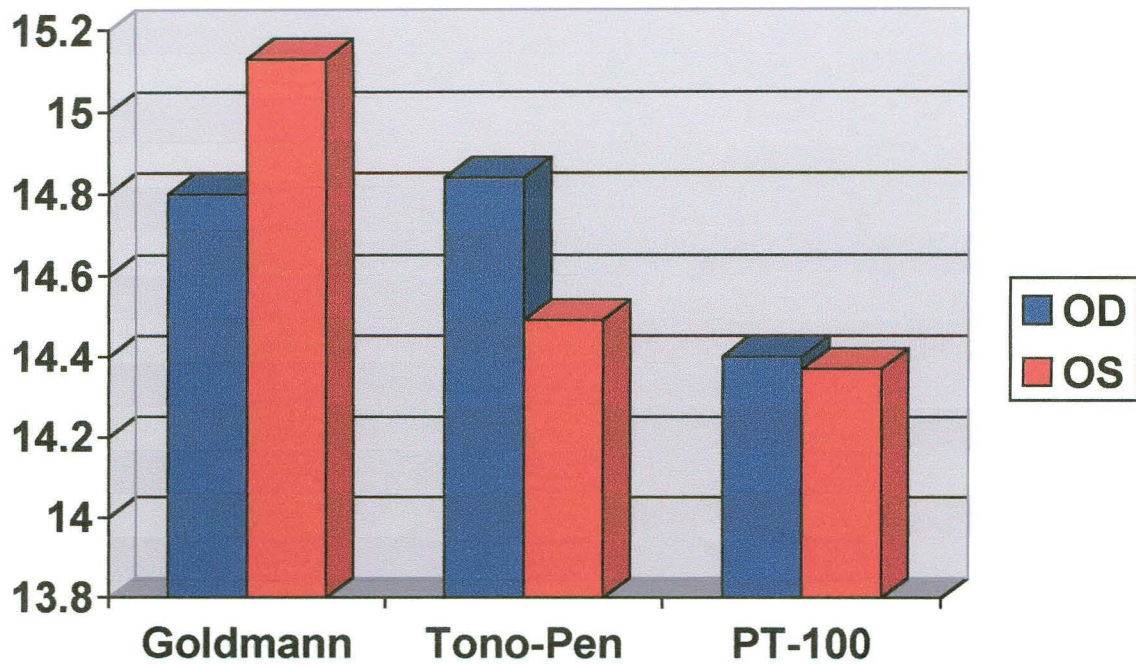
Date

Printed Name

Table 1

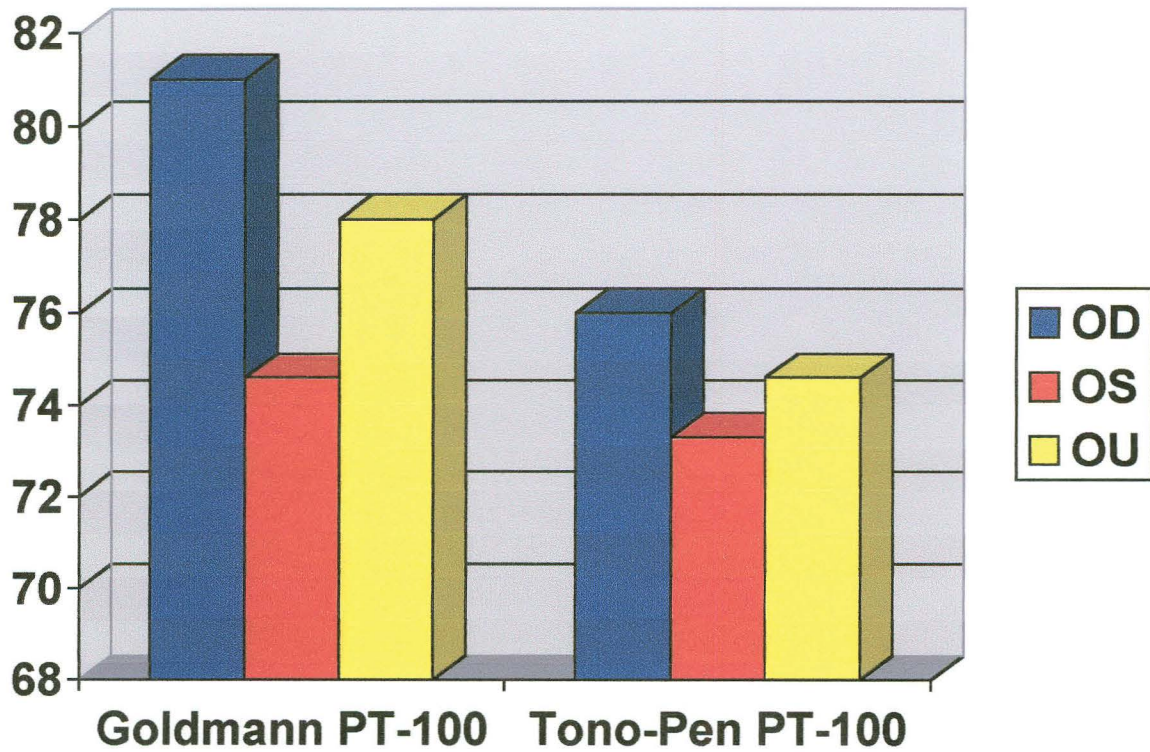
	Gold OD	Gold OS	T-P OD	T-P OS	PT-100 OD	PT-100 OS	Gold-PT OD diff	Gold-PT OS diff	TP-PT OD diff	TP-PT OS diff
Means	14.8	15.13	14.84	14.49	14.4	14.37	4.29	2.31	2.25	2.52
SD	3.263227	3.085858	3.296353	3.35862	2.78509547	3.021425				
	Gold OD	Gold OS	T-P OD	T-P OS	PT-100 OD	PT-100 OS				
r (corr)	0.445478	0.41993	0.557576	0.40507	0.52487471	0.52505988				
	B-D	C-E	D-F	E-G	F-B	G-C				
p (sign)	0.920386	0.115315	0.192257	0.76678	0.24837741	0.03011609				
95% CI	0.738523	0.698382	0.74602	0.76011	0.63031382	0.68379927				
Accuracy (within 3mmHg)							81%	74.60%	76%	73.30%
							Goldmann vs. PT100 OU 78%		TonoPen vs. PT100 OU 74.6%	

Graph 1



**Average IOP measurements
for Goldmann, Tono-Pen,
and PT-100 tonometers**

Graph 2



Accuracy (within 3 mmHg) of Pt-100 as compared with Goldmann and Tono-Pen