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Abstract

In this study the Keeler Pulsair non-contact tonometer was compared to itself in a test-retest study. IOP measurements from 20 subjects (age 5-42) were utilized. Five groups of four IOP readings were taken 15 minutes apart to minimize massage effect and eliminate diurnal effect. The mean readings were: 13.53 mm Hg with SD 3.6 mm Hg for OD and 13.39 mm Hg with SD 3.7 mm Hg for OS. The mean difference between tests was significant only for comparisons OD-1 vs.OD-2, OD-1 vs.OD-4 and OD-1 vs.OD-5 due to increased patient apprehension in group OD-1. The design of the Keeler Pulsair tonometer provides certain advantages over other tonometers with respect to special patient application and ease of operation. My results indicate there is a need for a future test-retest study which would deal further to alleviate patient apprehension.

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Dr. Paul Kohl

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A TEST-RETEST STUDY OF THE KEELER PULSAIR HAND-HELD TONOMETER

by Richard Toellner

A thesis submitted to the faculty of the
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Abstract

In this study the Keeler Pulsair non-contact tonometer was compared to itself in a test-retest study. IOP measurements from 20 subjects (age 5-42) were utilized. Five groups of four IOP readings were taken 15 minutes apart to minimize massage effect and eliminate diurnal effect. The mean readings were: 13.53 mm Hg with SD 3.6 mm Hg for OD and 13.39 mm Hg with SD 3.7 mm Hg for OS. The mean difference between tests was significant only for comparisons OD-1vs.OD-2, OD-1vs.OD-4 and OD-1vs.OD-5 due to increased patient apprehension in group OD-1.

The design of the Keeler pulsair tonometer provides certain advantages over other tonometers with respect to special patient application and ease of operation.

My results indicate there is a need for a future test-retest study which would deal further to alleviate patient apprehension.

Key Words: Intraocular Pressure(IOP), Keeler Pulsair Tonometer, Glaucoma, Massage Effect, Diurnal Effect

Introduction

The term "glaucoma" was first used by Hippocrates around 400 B.C. to describe a group of ocular abnormalities pertaining to the elderly.¹ The elevation of intraocular pressure (IOP), as a sign of eye disease was mentioned by Banister in 1626.¹ Today the most common causes of irreversible, acquired blindness are glaucoma, senile macular degeneration, and diabetic retinopathy.² The incidence of blindness from glaucoma is decreasing due to early detection and treatment.²

Diagnosis of glaucoma is usually determined by tonometry, gonioscopy, visual field evaluation, tonographic evaluations and provocative testing.³ Consequently, over the years, various types of instruments have been developed to measure IOP. Van Graefe produced the first indentation model in 1862, Goldmann created the applanation model in 1955, Mackay Marg's model was first available in 1959, and American Optical began manufacturing their non-contact tonometer in 1971.³

The purpose of this study was to 1) compare the IOP measurements taken by the Keeler Pulsair tonometer to itself in a test-retest study 2) determine the variability and correlations among the data collected.

Instrumentation

The Keeler Pulsair instrument consists of a small air compressor, in the form of a console, which is connected to a handpiece by a flexible cable. When the handpiece is correctly aligned to the patient's cornea with respect to distance as well as vertical and horizontal alignment, the image of the corneal reflex will fall on the photodetectors located inside the instrument. At this point, the air pulse is triggered automatically, flattening the cornea and changing the characteristics of the corneal reflex. There is a subflex button located on the handpiece which allows for readings to be taken on dry or distorted corneas. A button may also be pressed for intraocular pressures over 30 mm Hg., producing a measurable range from zero to 55 mm Hg.^{4,5}

Methods

Subjects:

Twenty patients ranging in age from 5 to 42, with a mean age of 25.55 years, were randomly selected from the population. Prior to testing, they were introduced to the Keeler Pulsair tonometer and its functions. The patients who had never experienced an air puff test, had it demonstrated to them on their hand.

Testing Procedures:

A total of 40 Keeler tonometer readings were performed on each patient; five sets of four readings per eye. For each of these trials alternation took place between the eyes, starting with the right eye. There was a 15 minute break in between each set of trials to minimize massage effect.

Results

The data gathered was analyzed by eye and trial. The minimum and maximum ranges for an individual eye IOP reading were 1 mm Hg and 5.5 mm Hg respectively. The population range was 13.5 mm Hg (8 mm Hg-21.5 mm Hg). Mean IOP's for the Keeler readings were: 13.53 mm HG with a SD of 3.6 mm Hg for OD and 13.39 mm Hg with a SD of 3.7 mm Hg for OS. The individual group means can be found in Table 1 and 2. A one factor ANOVA (repeated measures) with a 95% level of significance and Scheffe F- test post analysis, showed that the Keeler Pulsair readings when compared by group, showed no significant difference except for group comparisons OD-1vs.OD-2, OD-1vs.OD-4 and OD-1vs.OD-5 (Table 3 and 4). The four trials of one group were averaged, and the average compared to the average of the four trials in each of the other four groups for that eye.

The significant difference found in the above three group comparisons is hypothesized to have occurred due to patient apprehension on the first tested eye (group OD-1).

Discussion

The Keeler Pulsair tonometer gave consistent and repeatable readings with no significant difference for 17 of the 20 group comparisons. The three group comparisons, OD-1vs.OD-2, OD-1vs.OD-4 and OD-1vs.OD-5, which showed a significant difference at the 95 percentile, are hypothesized to be the result of patient apprehension of the first eye tested (OD-1). The mean of the IOP values of OD-1 is 14.538 mm Hg, while the means for the groups OD-2 through OD-5 were in the range of 13.0 to 13.7 mm Hg. The mean pressure of group OD-1 is considerably higher, making its comparison to the other groups significantly different.

The other six right eye comparisons not involving OD-1, all had an insignificant difference. None of the group comparisons for the left eye were significantly different. Since the right eye was tested first, this leads the examiner to believe the increased mean IOP for the group OD-1 caused the significant difference in the comparisons to OD-2, OD-4 and OD-5 due to patient apprehension.

This deviant finding may be eliminated by demonstrating the Keeler air puff on the right eye of the patient and disregarding this high figure due to patient apprehension. Four recorded readings would then be taken per eye.

Conclusion

My results show the Keeler Pulsair tonometer IOP readings to be consistent and repeatable with exception to the results obtained from the first eye tested. These IOP readings are significantly higher than subsequent groups of readings taken on the same eye. This is hypothesized to be due to patient apprehension causing the IOP to elevate.

In order for the Keeler to be accepted as a useful and trustworthy instrument for taking IOP's, further studies proving validity eliminating patient apprehension and studies comparing it to other proven and accepted instruments are needed.

TABLE 1: Group means and standard deviations for the right eye:

Group	Mean	Std. Dev.
OD-1	14.538	3.895
OD-2	13.137	3.36
OD-3	13.7	4.04
OD-4	13.275	3.314
OD-5	13.0	3.399

TABLE 2: Group means and standard deviations for the left eye:

Group	Mean	Std. Dev.
OS-1	13.613	3.619
OS-2	13.725	4.188
OS-3	13.363	3.595
OS-4	13.475	3.635
OS-5	12.775	3.245

TABLE 3: Group comparisons for the right eye:

Comparison	Scheffe F-test
OD-1vs.OD-2	3.564*
OD-1vs.OD-3	1.275
OD-1vs.OD-4	2.898*
OD-1vs.OD-5	4.298*
OD-2vs.OD-3	0.575
OD-2vs.OD-4	0.034
OD-2vs.OD-5	0.034
OD-3vs.OD-4	0.328
OD-3vs.OD-5	0.891
OD-4vs.OD-5	0.138

TABLE 4: Group comparisons for the left eye:

Comparison	Scheffe F-test
OS-1vs.OS-2	0.022
OS-1vs.OS-3	0.108
OS-1vs.OS-4	0.033
OS-1vs.OS-5	1.212
OS-2vs.OS-3	0.227
OS-2vs.OS-4	0.108
OS-2vs.OS-5	1.560
OS-3vs.OS-4	0.022
OS-3vs.OS-5	0.597
OS-4vs.OS-5	0.847

* Significant at 95%

TABLE 5: High-Low IOP readings

OD	OS	
9.25-21.6	8.7-19.55	in mm Hg

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