A Comparative Study of Intraocular Pressure Measurement between Gold-Mann Applanation Tonometer and Perkins Applanation Tonometer in Glaucoma Patients

Singh Punit[1], Thakkar Bhoomi[2], Kharas Hushedar[2], Pathak Mudra[3], Modi Samiksha[4], Mehta Niklank[4]

[1]Professor, Department of Ophthalmology, SBKS MI&RC, Piparia, Waghodia, Vadodara, India; [2]3rd-year resident, Department of Ophthalmology, SBKS MI&RC, Piparia, Waghodia, Vadodara, India; [3]DOMS, Department of Ophthalmology, SBKS MI&RC, Piparia, Waghodia, Vadodara, India; [4]2nd-year Resident, Department of Ophthalmology, SBKS MI&RC, Piparia, Waghodia, Vadodara, India.

ABSTRACT

Introduction: The study was performed to check the efficacy of intraocular pressure (IOP) measured by the Perkins applanation tonometry (PAT) over the gold-mann applanation tonometry (GAT) and to present and investigate the results, applying appropriate statistical methods.

Aims: To comparative intraocular pressure measurement between gold-mann applanation tonometer and Perkins applanation tonometer in glaucoma patients.

Methodology: Total 100 eyes (right eyes) of 100 patients underwent both types of instruments for measuring the intraocular pressure IOP which are gold-mann applanation tonometry (GAT) and Perkins applanation tonometry (PAT). Data collected were used for statistical analysis. Student t-test was used to find significance level between two study groups and $p < 0.05$ was considered as the significance level.

Result: Total 100 eyes of 100 patients were included. Intraocular pressure (IOP) values taken from the Gold-mann applanation tonometry (GAT) (which is a definitive measure) were ranged between 10-30 mmHg. Based on IOP all the population groups were divided into three groups the first group with IOP < 18 mmHg including 38 patients, the second group of 32 patients with IOP ranged between 18-24mmhg and the third group of patients with IOP >24mmhg.

The mean intraocular pressure (IOP) measured by gold-mann applanation tonometry (GAT) in our study was 22.45 mmHg. The mean intraocular pressure (IOP) measurements done by Perkins applanation tonometry (PAT) was 22.12 mmHg. The mean difference in the measurement of intraocular pressure (IOP) between the two instruments in our study was found 0.33 mmHg. By studying both the methods of measuring IOP it has been found in our study that there is not much significant difference in measuring IOP with both the methods it's only 0.33mmhg.

Conclusion: The intraocular pressure IOP measured from the Perkins applanation tonometer is highly comparable with the intraocular pressure IOP measured from the Goldman applanation tonometry (GAT).

Key Words: Glaucoma, Glaucoma patients, Goldmann applanation tonometry, Intraocular pressure, Perkins applanation tonometry, Student t-test

INTRODUCTION

Intraocular pressure (IOP) defines as the fluid pressure inside the eyeball. In glaucoma patients and ocular hypertension (OHT) patients, measurement of the intraocular pressure (IOP) is an important part of any ophthalmic examination.[1] Intraocular pressure (IOP) is one of the most important modifiable risk factors which leads to glaucomatous damage to the optic nerve. So intraocular pressure (IOP) is the best to target for the management of glaucoma. For the diagnosis and management of glaucoma, accuracy in the measurement of intraocular pressure (IOP) is the utmost priority.

Glaucoma, the 2nd leading cause of irreversible blindness worldwide.[2] The risk of the development of glaucoma increases with the increase in intraocular pressure (IOP). Increased

Corresponding Author:
Dr. Modi Samiksha, 2nd-year Resident, Department of Ophthalmology, SBKS MI&RC, Sumandeep Vidyapeeth, Piparia, Waghodia, Vadodara, India.
Email: samikshamodi46@gmail.com

intraocular pressure also increases the risk of worsening of pre-existing glaucoma.

The production of the aqueous humour and its outflow across the globe generates pressure which is defined as the intraocular pressure (IOP). At present, there is no safe and practical method available for the direct measurement of intraocular pressure (IOP). So intraocular pressure (IOP) is measured indirectly via non-invasive method as the trans-corneal pressure gradient.[3]

Gold-mann applanation tonometry (GAT) is esteemed as an ideal method for the measurement of intraocular pressure (IOP). It is approved as a part of NICE (National Institute for Health and Clinical Excellence) guidelines for measurement of intraocular pressure (IOP) in ocular hypertension and chronic open-angle glaucoma patients. Nevertheless, these guidelines do not support similarly Perkins handheld applanation tonometer (PAT). They state that the Perkins applanation tonometry (PAT) which is the type of hand-held tonometry is a very useful method for screening the patient who cannot sit on the slit-lamp. But there are no arguments to submit that these methods are similar to the Gold-mann applanation tonometry (GAT).[4]

Therefore, our study aimed to check the efficacy of intraocular pressure (IOP) measured by the Perkins applanation tonometry (PAT) over the Goldmann applanation tonometry (GAT) and to present and investigate the results, applying appropriate statistical methods.

MATERIALS AND METHODS

After obtaining approval from the ethical committee of SBKS MI&RC, piparia, waghodia, Vadodara the study was conducted.

The ethical clearance no: SVIEC/ON/MEDIL/BNPG20/D2114

One hundred patients with the diagnosis of glaucoma were included in the study who came for the regular follow up in the Dhiraj hospital, Vadodara.

Inclusion Criteria:
- Patients having primary open-angle glaucoma (POAG).
- Patients having primary angle-closure glaucoma (PACG).
- Patients having normal-tension glaucoma.
- Patients having ocular hypertension.
- Willing to participate.

Exclusion Criteria:
- Pathology of the cornea like keratoconus, corneal scarring, previous corneal surgery, corneal infection.

- Congenital glaucoma.
- Secondary glaucoma.
- Physical inability to sit on the slit lamp or keep open the eye.
- Microphthalmos, buphthalmos, nystagmus, and blepharospasm.
- Patients having astigmatism >3D.
- Patients were not willing to participate.
- Patients having age<18 yrs.

The ethics committee was informed respecting our study design, and approval was given. All of these patients were already undergoing intraocular pressure measurement (IOP) as routine ophthalmic examination care. So the intraocular pressure measurement (IOP) measured by Perkins applanation tonometry (PAT) did not require serious ethic permission from the institution.

Measurement of the intraocular pressure (IOP) was done for all patients with the Goldmann tonometer (GAT) and Perkins Mk2 tonometer (PAT). Before starting the examination, calibration of the instruments was done. A common method for intraocular pressure (IOP) measurement was followed. Topical anaesthesia was applied and the eyes were stained with fluorescein dye. The eyes were wiped, to get rid of excessive stains from eye. Measurement was executed by the same masked investigator. Before each measurement, the tonometer was set to an IOP value of 10 mmHg. Then, the button was turned until the appropriate mires met the inner edges.

The position of the patient was kept sitting while measuring the applanation. During gold-Mann applanation tonometry (GAT), the plane of the face of the patient was kept vertical. While during Perkins applanation tonometry (PAT), the head of the patient was inclined 30 degrees backwards.

The prisms used in the tonometer were reusable. Prisms were purified and disinfected between each use, by the manufacturer's recommendation.

First, the intraocular pressure (IOP) of the right eye was measured with both the instruments and these values were used for analysis. An average of 3 readings was taken with each instrument and the mean of these values was used for the result analysis.

Student t-test was used to find significance level between two study groups and $p < 0.05$ was considered as the significance level.

RESULTS

Total 100 eyes of 100 patients were included. Intraocular pressure (IOP) values taken from the gold-mann applanation tonometry (GAT) (which is a definitive measure) were ranged between 10-30 mmHg. By using these values all eyes were divided into three groups showing in the table.

Table 1: Number of eyes with variable IOP range

IOP range	Number of the eyes
< 18 mmHg	38
18-24 mmHg	32
>24 mmHg	30

In the analysis, we used only one eye measurements which is the right eye. The mean intraocular pressure (IOP) measured by Gold-Mann applanation tonometry (GAT) was 22.45 mmHg. The standard deviation (SD) was 6.47 mmHg. The mean intraocular pressure (IOP) measured by Perkins applanation tonometry (PAT) was 22.12 mmHg. The SD is5.78 mmHg. The mean difference between the measurements of the two instruments was 0.33 mmHg.

Table 2: Comparison of IOP measurement between GAT and PAT

Group	Mean IOP	SD	P-value
GAT	22.45	6.47	0.969
PAT	22.12	5.78	

In the 1st group where eyes containing IOP <18 mmHg, the mean IOP measured by Gold-Mann applanation tonometry (GAT) was 17.45 mmHg, with a standard deviation (SD) of 2.47 mmHg. The mean IOP measured by Perkins applanation tonometry (PAT) was 17.14 mmHg, with a standard deviation (SD) of 3.61 mmHg. The mean difference of IOP measured by two instruments that is Gold-Mann applanation tonometer and Perkins applanation tonometer in this group was 0.31 mmHg.

Table 3: Comparison of IOP measurement (<18 mm of Hg) between GAT and PAT

Group 1 (< 18 mmHg IOP)	Mean IOP	SD	P value
GAT	17.45	2.47	0.943
PAT	17.14	3.61	

In the 2nd group where a total of 32 eyes with IOP ranges between 18-24 mmHg were included. The mean IOP measured by Gold-Mann applanation tonometry (GAT) was 21.85 mmHg, with a standard deviation (SD) of 3.65 mmHg. The mean IOP measured by Perkins applanation tonometer (PAT) was 22.05 mmHg, with a standard deviation (SD) of 4.19 mmHg. The mean difference of IOP measured between Gold-Mann applanation tonometry (GAT) and Perkins applanation tonometry (PAT) in this group was 0.20 mmHg.

Table 4: Comparison of IOP measurement (18-24 mm of Hg) between GAT and PAT

Group 2 (18-24 mmHg IOP)	Mean IOP	SD	P value
GAT	21.85	3.65	0.971
PAT	22.05	4.19	

In the 3rd group where a total of 30 eyes whose intraocular pressure IOP> 24 mmHg were included. The mean IOP measured by Gold-Mann applanation tonometry (GAT) was 27.63 mmHg, with a standard deviation (SD) of 4.21 mmHg. The mean IOP measured with Perkins applanation tonometry (PAT) was 27.75 mmHg, with a standard deviation (SD) of 2.75 mmHg. The mean difference of the IOP measured between the Gold-Mann applanation tonometer (GAT) and Perkins applanation tonometer (PAT) was 0.12 mmHg.

Table 5: Comparison of IOP measurement (>24mm of Hg) between GAT and PAT

Group (> 24 mmHg IOP)	Mean IOP	SD	P value
GAT	27.63	4.21	0.981
PAT	27.75	2.74	

DISCUSSION

Accuracy in the measurement of IOP is a primary aim for the diagnosis and management of Glaucoma. The studies done on glaucoma have stressed the significance of IOP in the diagnosis and management of glaucoma.[5,6] Gold-Mann applanation tonometry (GAT) is the method of choice for measuring the intraocular pressure (IOP) used by all ophthalmologists. The reason behind this is Gold-Mann applanation tonometry (GAT) has accurate results, is easy to handle and least inter and intra-observer variability.[7] The precision of these tonometers depends on many factors like the curvature of the cornea, central corneal thickness and astigmatism. Many studies have reported that intraocular pressure (IOP) is affected by the curvature of the cornea. There has been an overestimation of the intraocular pressure (IOP) if the cornea is thick while thin corneas lead to underestimation of the intraocular pressure (IOP).[8]

The Perkins applanation tonometer (PAT) is the type of portable hand-held tonometer. There are many conditions where patients can't sit on slit-lamp like children, bedridden patients, anaesthetized patients. Perkins applanation tonometry (PAT) is recently in wide use in the primary setting.

Many studies done on animals supported the association and precision of Perkins applanation tonometry (PAT).[9,10] In one study done on horses and cattle Andrade et al showed a strong association between measurements of intraocular pressure (IOP) done by Perkins applanation tonometry (PAT)

and ocular manometry.[11] Fewer studies have been done on humans. Because of the similar physical properties and same basic instrument formation, Perkins applanation tonometer (PAT) should be equivalent to Gold-Mann applanation tonometer (GAT). Previous similar studies are not significant as there was a very small sample size, so delivering weak evidence.

Our study also supported the results of one another similar study was done by Arora et al. Their study reported the mean intraocular pressure (IOP) measured by Gold-Mann applanation tonometry was 21.63 mmHg. The mean intraocular pressure (IOP) measured by Perkins applanation tonometry (PAT) was 21.40 mmHg. Therefore, the mean difference in the measurement of intraocular pressure (IOP) between the two instruments in their study was 0.22 mmHg.[12] Our study also showed similar results. The mean intraocular pressure (IOP) measured by Gold-Mann applanation tonometry (GAT) in our study was 22.45 mmHg. The mean intraocular pressure (IOP) measurements done by Perkins applanation tonometry (PAT) was 22.12 mmHg. The mean difference in the measurement of intraocular pressure (IOP) between the two instruments in our study was found 0.33 mmHg.

During Gold-Mann applanation tonometry (GAT), many mechanical and anatomical difficulties occur for putting the chin over the slit lamp in the correct position. This leads to changes to the heart and circulatory system by causing fear, distress, contraction of muscles. Pushing thorax and abdomen against the slit lamp and table while breath-holding works like a Valsalva manoeuvre. Valsalva-like manoeuvres frequently are encountered in many daily activities like lifting heavy loads, defecation, playing wind instruments, coughing, and vomiting.[13] Epstein[14] recommended the utilization of the Perkins portable tonometer on obese patients to avoid false IOP elevations due to breath-holding when measured with the slit lamp. This fact is not widely known among practising ophthalmologists.

In an article about sources of error in the use of Gold-Mann type tonometers by Whitacre and Stein,[15] similar IOP-influencing factors, such as increased venous pressure from tight clothing or the Valsalva manoeuvre, were reported, but not the transitory IOP increase in obese patients. It was noted that there is a transient increase in the IOP during concurrent chest compression and breath-holding.

Perkins applanation tonometry (PAT) would appear to be similar to the "gold standard" of slit lamp-mounted Gold-Mann applanation tonometry. These eyes were selected according to the inclusion and exclusion criteria. Therefore, we consider it to be acceptable for routine clinical practice, not simply to be observed as a "second best", for when slit lamp-mounted GAT is not possible. According to our study, we found that measurement of intraocular pressure (IOP) by Perkins applanation tonometry (PAT) was comparable to Gold-Mann applanation tonometry (GAT) for the diagnosis and management of Glaucoma.

CONCLUSION

In our study groups which were chosen on random selection criteria, after meeting all the inclusion criteria and excluding the patients who were not fit for our study, In this study 100 patients were enrolled and each individual's eye was examined for Intra Ocular pressure with GAT and PAT. All the bias factors which may contribute to false errors and which may produce an impact on the results of our study like age, sex, corneal abnormalities, MGD, tear film instability were removed.

All the variable IOP ranging from 18mmHg to 24mmHg were compared with both the tonometers. Three population groups were divided based on IOP not based on age, sex, race, ethnicity or other factors so that variables in our study were minimum, unlike other studies. In this study, the mean intraocular pressure (IOP) measured by Goldmann applanation tonometry (GAT) in our study was 22.45 mmHg. The mean intraocular pressure (IOP) measurements done by Perkins applanation tonometry (PAT) was 22.12 mmHg. The mean difference in the measurement of intraocular pressure (IOP) between the two instruments in our study was found 0.33 mmHg. As Gold-Mann applanation tonometry (GAT) is considered the gold standard and most widely used method of tonometry but there is little significant difference of IOP measured with Perkins tonometer as observed in our study. Both the tonometers can be considered as the method of accurate measurement of IOP according to the treating doctor.

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I Dr Samiksha Modi, corresponding and 6th author of this article, conducted a tonometry examination of all patients, I collected data in documented forms as well all patients' consent and comfort were kept in mind.

I would like to say thanks to my readers of this article and would like to request if they have any query or anything they find in this article inappropriate or irrelevant kindly write to me.

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