ORIGINAL RESEARCH

Comparative Analysis of Intraocular Pressure Measurements using Perkins Tonometer and Non-contact Tonometer in a Rural Tertiary Care Hospital in Northern Maharashtra, India

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Abstract

Purpose: Measurement of IOP is one of the basic investigations in a general ophthalmic workup. To compare intraocular pressure measurements, taken by using Perkins applanation tonometer (PAT) and non-contact tonometer. Perkins's tonometer is a portable form of GAT (Goldman applanation tonometer) which is gold standard applanation tonometer. It is easy to handle, used in children, bed ridden patients. Non-contact tonometer doesn't require anaesthesia. It is non-invasive and easy to handle .and used in mass screening.

Methods: An Analytical study in which IOP was measured in patients using the two tonometers. All patients attending ophthalmic OPD will be going for a detailed ophthalmic examination of both eyes.

Results: The study population included 35 patients and 70 eyes. There is statically significant difference seen for the values between the tonometers. There was no significant difference seen for the IOP values between right eye and left eye and also there is no stastically significant difference in between male and female.

Conclusion: In this study, 70 eyes in a tertiary care center had their IOP tested using a Perkins tonometer and a non-contact tonometer for both sexes. The results were compared. As our institution is an educational, we had equal access to both tonometers. Perkins is a more accurate tonometer than a non-contact tonometer since it is portable and simple to use as a bedside approach. A statistically significant difference was observed in the IOP measurement when utilizing a non-contact tonometer and a Perkins tonometer.

Keywords: Perkins applanation tonometer, Non-contact tonometer, Intraocular pressure, tonometry, Screening tool.

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Introduction

Maintaining normal intraocular pressure (IOP) is vital for preserving the structural integrity of the eye and ensuring proper visual function. A prolonged rise in IOP can lead to irreversible damage to the postganglionic nerve fibers and retinal ganglion cells, potentially resulting in glaucoma.[1] Elevated IOP is a significant and easily identifiable modifiable risk factor for the progression of glaucoma. On the other hand, ocular hypotony can have severe and detrimental effects on the eye and vision. Causes of ocular hypotony include reduced ciliary body perfusion (ocular ischemic syndrome), cyclodestructive procedures, glaucoma filtering surgeries, hematogenous retinal detachment, and vitreoretinal surgery.[7] Proper evaluation and treatment of ocular hypotony can help reverse the condition and restore vision.

Therefore, accurate measurement of IOP is critical for initiating treatment and monitoring its effectiveness. Over the last few decades, tonometry techniques have evolved rapidly, with new equipment ensuring more precise IOP assessments.[1] The Goldmann applanation tonometer (GAT) is widely considered the gold standard for measuring IOP. The GAT uses the Imbert-Fick principle to measure the force required to applanate a specific section of the cornea to determine pressure. However, it is generally acknowledged to be less accurate in eyes that have undergone refractive surgery, as it requires the use of a slit lamp microscope and pressure recording under specific conditions.[6]

The Perkins tonometer, a portable version of the GAT, retains the same principle and provides an easy-to-use, portable, and reliable method for measuring IOP. It can be used safely

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during the postoperative period and in retinal detachment surgeries, making it a reliable alternative to the Goldman tonometer.[4] Furthermore, the Non-Contact Tonometer (NCT) offers a non-invasive method for measuring IOP, requiring no topical anesthesia. It operates on the principle that IOP is determined by the time taken for an air jet to applanate the cornea, which is proportional to the power of the air sprayed from the instrument.[6]

Methodology

This hospital-based analytical observational study was conducted at a tertiary care hospital in Northern Maharashtra. The sample size was calculated using the formula for comparing two means, incorporating parameters such as significance level (Z1-α/2=1.96 for α=0.05), power (Z1-β=0.84 for 80%), mean values (μ1, μ2), and standard deviations (σ1, σ2) of the two groups, resulting in a total of 70 eyes from 35 individuals.

The study included patients aged 18 to 65 years attending the Ophthalmology Department. Patients were excluded if they had active infections or inflammation of the anterior segment, were non-cooperative or psychologically unstable, had ocular surface irregularities, nystagmus, pre-existing corneal pathologies, or had undergone corneal procedures or surgeries within the past month. Additionally, those who refused consent were not included in the study. These criteria ensured the selection of participants whose intraocular pressure (IOP) measurements could be reliably assessed without confounding factors.

A detailed history and thorough anterior and posterior segment examinations were conducted. IOP was measured using NCT and Perkins Tonometer, with measurements taken by a single surgeon to minimize inter-observer bias, starting with the right eye and conducted between 9:00 AM and 3:00 PM to control for diurnal variations. The NCT procedure included three measurements spaced 8–10 seconds apart, with a 'click' sound demonstrated to the subject to avoid startled movements. For the Perkins Tonometer, 4% proparacaine drops and fluorescein strips were used to stain the tear film, and the gearwheel mechanism was employed to align hemispherical mires, recording the endpoint when their inner edges coincided. Pressure levels were calculated based on the readings, with all recorded data systematically analyzed. Data were entered into MS Excel and analyzed using SPSS software.

Descriptive statistics were used to summarize demographic data, while unpaired t-tests were applied to compare measurements obtained by Non-Contact Tonometer (NCT) and Perkins Tonometer, with a *p-value* < 0.05 considered statistically significant. Patients aged 18–65 years attending the Ophthalmology Department were included, while those with active infections, anterior segment inflammation, ocular surface irregularities, nystagmus, pre-existing corneal pathologies, recent corneal surgeries (< 1 month), or those refusing consent were excluded.

Results

The study included 35 individuals (70 eyes) to compare intraocular pressure (IOP) measurements using the Non-Contact Tonometer (NCT) and Perkins tonometer.

Table 1: Socio-demographic Profile of Study Participants.

Variable	Level	N (35)	%
Gender	Female	12	34.29%
	Male	23	65.71%
AGE	Mean	55.9429	
	Std Dev	9.8397	
	Min	23	
	Median	60	
	Max	65	
	Mode	63	

The study included 35 participants, with 23 males (65.71%) and 12 females (34.29%). The mean age of the participants was 55.94 years, with a standard deviation of 9.84 years, indicating a diverse age range. The youngest participant was 23-years-old, while the oldest was 65-years-old. The median age was 60 years, and the most frequently occurring age (mode) among participants was 63 years. This age distribution reflects a predominantly middle-aged and older population, which is relevant for to study intraocular pressure in relation to aging.

Inter-group comparison of IOP values measured by Perkins tonometer. The IOP measurements using the Perkins tonometer ranged from 10 to 22 mmHg, with a mean IOP of 15.11 mmHg. The mean IOP for males was 14.50 mmHg, while females had a higher mean IOP of 16.29 mmHg.

Inter-group comparison of IOP values measured by Non-Contact Tonometer: The IOP measurements using the NCT ranged from 11 to 27 mmHg, with a mean IOP of 16.74 mmHg. The mean IOP for males was 16.17 mmHg, whereas for females, it was 17.96 mmHg. When analyzing IOP by eye, the mean IOP for the right eye was 16.83 mmHg, and for the left eye, it was 16.74 mmHg.

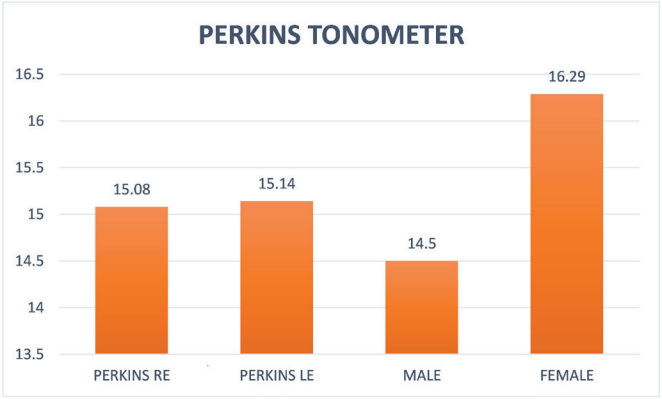

Figure 1: Inter group comparison of values of IOP measured by Perkins Tonometer.

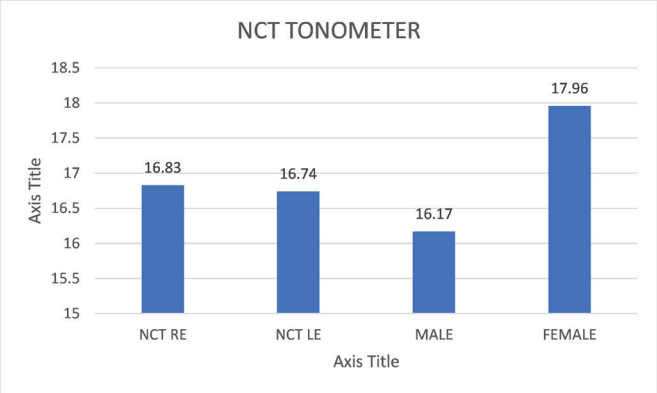

Figure 2: Inter group comparison of values of IOP measurement by Non-contact Tonometer.

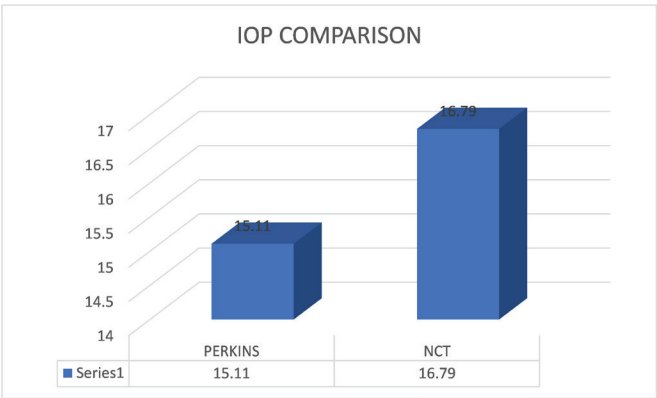

Figure 3: Inter-technique comparison of IOP values.

A statistically significant difference was observed between the IOP values measured by the Perkins tonometer and the NCT, with the NCT consistently showing higher values. The mean difference between the two techniques was 1.68 mmHg, indicating a systematic variance between the measurements.

The Bland-Altman plot demonstrated that the IOP measurements obtained by the Perkins tonometer correlated more closely with true IOP values compared to the NCT, further supporting the accuracy of the Perkins tonometer.

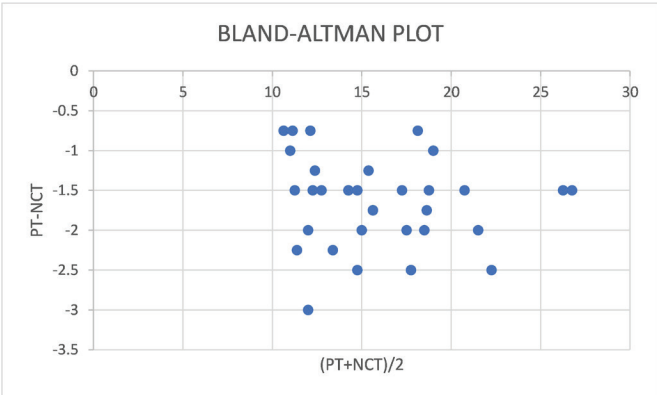

Figure 3: Bland-Altman plot analysis.

Discussion

This is the first study conducted in a tertiary care hospital in Northern Maharashtra comparing IOP measurements between Perkins and Non-Contact Tonometer (NCT). Various tonometers are available for measuring IOP, including Perkins, NCT, Goldmann Applanation Tonometer (GAT), and Schiotz tonometer, each with its unique advantages and disadvantages. Accurate IOP measurement is critical for diagnosing and managing conditions such as glaucoma. Perkins tonometer is a portable version of GAT, both of which operate on the Imbert-Fick principle, which states that the external force applied to a sphere equals the pressure inside the sphere multiplied by the flattened area of the sphere, as explained in the study by R. Ramakrishnan, M. Agrawal, and S. Kalapad *et al.*[11]

The Perkins tonometer is handheld and portable, making it ideal for use with bedridden patients or in operating rooms. It provides IOP measurements comparable to the GAT, as highlighted in the study by D.K. Sinha.[9] However, since it requires direct contact with the cornea, it necessitates the usage of anesthetic drops and carries a slight risk of infection if not properly sanitized. In contrast, the NCT tonometer is often used by optometrists and ophthalmology students due to its simplicity. It uses an air puff to measure IOP, minimizing the risk of cross-infection and corneal damage, but its accuracy is lower compared to other tonometer's, often exaggerating IOP values, as noted by D.K. Sinha[9] Our study findings align with previous studies, such as the one by Arora *et al.*[12], which demonstrated that Perkins's tonometer yields measurements closely comparable to GAT, suggesting its reliability in routine practice. Similarly, Swati Nagarajan A *et al.*[10] found that Perkins and Schiotz tonometers performed better than NCT. In our study, the Perkins tonometer showed higher accuracy than the NCT, reinforcing its status as a gold-standard tool for IOP measurement.

The Bland-Altman plot further indicated that the Perkins tonometer correlates better with true IOP values than the NCT. While NCT and Perkins tonometers are both suitable for quick mass screenings, such as in camp settings, Perkins tonometer is particularly useful for community-level screenings to detect elevated IOP. These findings underscore the clinical utility of the Perkins tonometer for precise IOP measurements, particularly in scenarios requiring high accuracy or in patients where GAT may not be feasible.[9]

Conclusion

In conclusion, this study highlights the comparison of intraocular pressure (IOP) measurements between the Perkins tonometer and the Non-Contact Tonometer (NCT) in a cohort of 35 individuals, predominantly male (65.71%) and aged between 23 and 65 years. The findings suggest that the Perkins tonometer provides more accurate and reliable IOP measurements compared to the NCT, with a statistically significant difference between the two methods. While the mean IOP measured by both tonometers was comparable,

the Perkins tonometer showed a closer correlation to true IOP values. The study also demonstrates that both tonometers are useful for IOP measurement in diverse populations, but the Perkins tonometer is particularly advantageous in clinical settings requiring precise and consistent measurements.

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