



Comparison of Noncontact Tonometer with Goldmann Applanation Tonometer for Intraocular Pressure Measurement in Non-Glaucomatous Patients in Central India.

KEYWORDS

IOP: Intraocular Pressure, GAT: Goldmann Applanation tonometer, NCT: Noncontact tonometer, CCT: Central corneal thickness

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ABSTRACT The intraocular pressure (IOP) value is a vital parameter in the detection of Glaucoma. The Goldmann Applanation tonometer (GAT) has been the "gold standard" for IOP measurements despite its inherent shortcomings. The IOP measurement by GAT requires topical anesthesia and direct corneal contact. The use of GAT can cause corneal abrasion and carries risk of spread of infection. The process requires expertise and is time consuming. The Non contact tonometer (NCT) is an alternate tool for IOP measurement. It uses rapid air puff for IOP measurement. It does not require anesthesia or corneal contact and can be operated with relative ease as compared with GAT. The NCT is portable instrument, carries no risk of infection, especially well suited in post refractive surgery patients. Several studies available on comparison of NCT with GAT established that IOP measurements by NCT are comparable to IOP measurements by GAT, while there are still good number of studies reporting no statistical co-relation between IOP measurements by NCT and GAT. Aims: To compare NCT with GAT for IOP measurements in non-glaucomatous patients in central India., Settings and Design: Simple random study, Methods and Material: The IOP measurements of 597 eyes in 300 non-glaucomatous patients were taken using both NCT and GAT tools in central India. The IOP was first measured by NCT and then by GAT in same patient after a gap of 10 minutes., Statistical analysis used: Student's t-test & the Bland Altman methods. The analysis was carried using Microsoft Excel., Results: Mean IOP reading by NCT is 14.73mm of Hg with a standard deviation of 2.68 whereas the Mean IOP reading by GAT is 12.61mm of Hg with a standard deviation of 2.65. The difference in readings is statistically significant $p = 0.0001$., Conclusions: Mean difference of IOP was statistically significant in NCT and GAT. So NCT should not be used as diagnostic tool for IOP measurement. However NCT can be used as a screening tool in community practice.

Introduction:

Intraocular pressure is an important ocular parameter that has significant influence in the diagnosis, development and management of glaucoma.^[1,2] Glaucoma is a leading cause of irreversible blindness worldwide.

Goldmann Applanation tonometer is inferred from the force required to flatten (applanate) constant area (3.06 mm) of the cornea as per the Imbert-Fick law.^[3] Surface anesthesia is required. It is considered to be gold standard test and is the most widely accepted method.^[4,5] Non contact tonometer is invented by Bernard Grolman of Reichert, Inc. (formerly American optical). It uses a rapid air pulse to applanate (flatten) the cornea. Corneal applanation is detected via an electro optical system. The IOP is estimated by detecting the force of air jet at the instance of applanation.^[6] The NCT is very useful measurement tool in children, patients with infected eye and patients who have undergone recent surgery, since IOP can be measured without any risk of microbial contamination or contact.

The clinical evaluation of NCT was done by B Shridhar Rao.^[7] This study was designed to evaluate the NCT in glaucomatous and non-glaucomatous patients and to compare these IOP readings with that of GAT. He observed that patient's acceptance of NCT is good and stated that the NCT can be considered as a valuable screening device and can be used routinely for measuring IOP in all patients. As per study done by Farhood QK, there is a significant difference in the measurements of IOP between GAT and NCT.^[8] The study indi-

cated that measurements of IOP by NCT are usually higher than those obtained by GAT regardless of the patient's age, sex, or laterality of eyes. He concluded that GAT remains the most suitable and reliable method for measuring IOP, whereas NCT is a suitable method for community or mass screenings of IOP. The present work compares IOP measurements obtained by NCT with IOP measurements obtained by GAT in non-glaucomatous patients and to see if how well NCT compares to GAT.

Subjects and Methods:

The IOP readings were taken in a total of 300 patients (total 597 eyes) using both NCT and GAT. The study was performed at general hospital in central India. Simple random sampling method was used for selecting patients with inclusion and exclusion criteria mentioned below.

Inclusion criteria:

Male and female patients in equal proportion

Patients older than 16 years and less than 80 years Patients willing to give written informed consent

Exclusion criteria:

Patients with history of glaucoma

Patients with IOP readings more than 26 on NCT

Patients were explained the procedure in detail and a written informed consent was taken adhering to the tenets of the 'Declaration of Helsinki' principles for research in human subjects. The identity of the patient will not be disclosed.

Detail history taken including HTN, DM, and other illnesses. Visual acuity was taken by Snellins chart. Autorefractometer readings were taken. Refraction was done. Patient was examined on slit lamp for detail anterior segment evaluation. Fundus examination was done using 90D.

IOP reading was first taken with NCT to avoid direct corneal contact and its influence on IOP readings. Procedure was explained and position was given to the patients with chin adjustment. The mean of three readings was considered (default setting of instrument)

The IOP measurement in same patients was carried out using GAT after a gap of 10 minutes. Proparacaine 0.5% drops installed. Fluorescein staining was done by fluorescein strip. IOP measured in cobalt blue filter uniocularly. The mean of three readings was considered.

Central corneal thickness measured with pachymeter. Blood pressure was taken by BP apparatus.

Results:

There were 159 female patients (53%) and 141 (47%) male patients. The mean age for all of 300 patients was 45.61 ± 16.62 years (range 17 to 83). Three patients had one eye (two phthisis bulbi, one staphyloma) so total of 597 eyes were considered for study. The mean IOP as measured by NCT was 14.73 ± 2.68 mm of Hg (range 6 to 26) whereas the mean IOP as measured by GAT was 12.65 mm of Hg (range 8 to 23). The mean CCT was $522.37 \mu\text{m} \pm 34.36$ (range 427 to 614). Refer Table 1

	Mean	Stand- ard devia- tion	Min	Max	Observations
Age (Years)	45.61	16.62	17	83	300 (159 female, 141 male)
IOP GAT (mmHg)	12.61	2.65	8	23	597
IOP NCT (mmHg)	14.73	2.68	6	26	597
CCT (μm)	522.37	34.36	427	614	597

Table 1 Distribution of observations (IOP GAT – Goldmann applanation Tonometer, IOP NCT – Non contact Tonometer, CCT – central corneal thickness)

Student's t-test was performed for assessing the statistical significance of the difference between two sample means of IOP reading obtained by NCT and GAT. The p value was found to be less than 0.0001 so the differences in readings are statistically significant (that is, the observation is highly unlikely to be the result of random chance alone). Refer Table 2.

	Mean	Standard devia- tion	p
IOP GAT Vs IOP NCT	2.12	0.03	0.0001

Table 2 Comparison of IOP readings between GAT – Goldmann applanation Tonometer and NCT- Non contact Tonometer

The Bland Altman method was used for assessing the agreement between IOP readings obtained by GAT and NCT. It shows very poor correlation between readings. Refer Figure 1

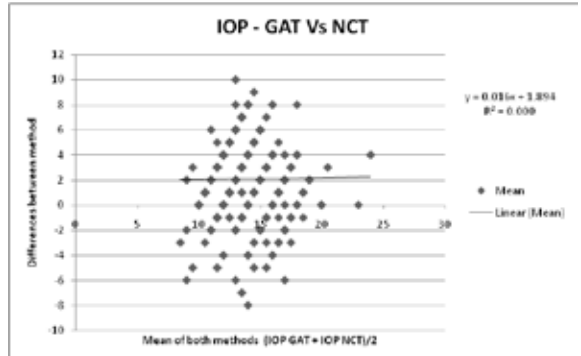


Figure 1 Bland and Altman Plot of IOP data obtained by GAT and NCT. Correlation R = 0.0136 (P=0.74). Slope = 0.0164 (P=0.74). Intercept = 1.894 (P<0.01)

The readings match in 13.57% eyes. The absolute difference between IOP readings on two tools is within 0-3 mm oh Hg in 67% eyes whereas the difference is more than 3 mm oh Hg in 33% eyes. The difference is more than 6 in 13% eyes.

Though NCT readings produce higher values compared to GAT, the readings are on higher side on lower GAT readings. The age, sex, laterality of eye, corneal thickness has no influence on the values. Refer Figure 2

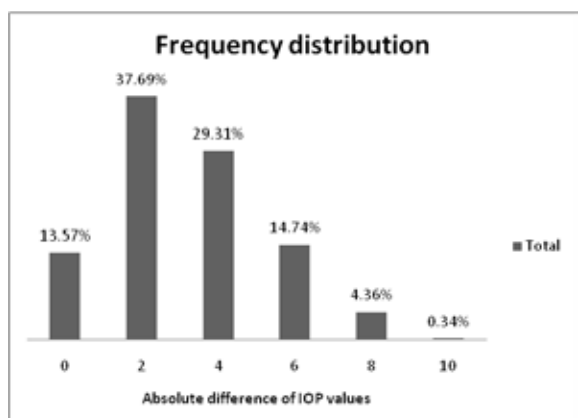


Figure 2 Frequency distribution of absolute difference of IOP values (GAT Vs NCT)

Discussion:

As per Cesk Slov et al the IOP measurements were much higher at NCT as compared to GAT. [9] According to Jorge J the NCT overestimated the IOP compared with GAT in normal, healthy eyes by about 1.7 mmHg on average (95% confidence) in the range of -2 to +6 mmHg. [10] We observed that IOP readings were on higher side as compared to GAT by 2.12 mmHg on average in 73% eyes (435 of 597). Only 13.5% observations (81 readings) produced lower IOP value as compared to GAT.

According to Kim N R et al IOP measurement differences in three tonometers (GAT, Tonopen and NCT) are affected by age, type of glaucoma, CCT, IOP levels. [11] We considered the effect of age, laterality of eye and CCT on the IOP measurement difference, but found no correlation.

Though NCT readings produce higher values compared to GAT, we found the readings are on higher side on lower GAT readings. The readings match in 13.57% eyes. The absolute difference between two readings is within 0-3 range in 67% eyes whereas the difference is more than 3 in 33% eyes. The difference is more than 6 in 13% eyes. Based on the distribution of readings it can be inferred that NCT should not be

used for diagnostic purpose, but can be used as screening tool for community practices. It's in line with study conducted by Mohan S - pulsair NCT can be used as screening tool for community practices but is not reliable in subjects with higher IOP range in Indian population.^[12]

Conclusion:

The mean difference of IOP was statistically significant in NCT and GAT (mean difference 2.12, standard deviation difference 0.03, $p < 0.0001$). There are more chances to miss true positive cases by NCT. Hence NCT should be used for diagnostic purpose. However it can still be used as screening tool during mass or community screening.

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