CORRELATION OF INTRAOCULAR PRESSURE MEASUREMENTS WITH NON CONTACT TONOMETER AND GOLDMANN APPLANATION TONOMETRY

Leya Sara George[1], Arun Bhatti[2], Nitin Batra[3], Rupali Chopra[4]

[1]Postgraduate Resident, Department of Ophthalmology, CMC, Ludhiana.
[2]Senior Resident, Department of Ophthalmology, CMC Ludhiana.
[3]Professor and HOD, Department of Ophthalmology, CMC Ludhiana.
[4]Professor, Department of Ophthalmology, CMC Ludhiana.

ABSTRACT

BACKGROUND

A complete ophthalmologic examination includes intraocular pressure (IOP) measurement, which is a routine procedure and is important for diagnosis and monitoring of glaucoma. IOP measurement is most commonly done using Goldmann Applanation tonometer and Non-Contact tonometer.

MATERIALS AND METHODS

In this study IOP measurements of 500 eyes (glaucomatous and non-glaucomatous) were performed using GAT and NCT on patients visiting the outpatient clinic of Department of Ophthalmology at Christian Medical College and Hospital, Ludhiana. This was a cross sectional and observational study. Comparison of IOP values was done in different IOP ranges. CCT was measured and analysis of its correlation with GAT and NCT was done.

RESULTS

Both methods of tonometry correlated significantly in patients with IOP <24 mm Hg. The mean IOP measured by NCT, was 16.06 ± 5.85 mm Hg and the mean IOP measurement by GAT was 16.61 ± 6.94 mm Hg. Intraocular pressure readings with GAT and NCT positively correlated with CCT.

CONCLUSION

NCT may be useful for screening in clinical settings but borderline high IOP readings should be confirmed with GAT. Our findings, also suggest that CCT is an essential variable to consider in interpreting IOP readings.

KEYWORDS

Applanation Tonometer, Intraocular Pressure, Non-Contact Tonometer.

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BACKGROUND

Glaucoma is an optic neuropathy of multivariate aetiology wherein intraocular pressure (IOP) is the most important and only modifiable risk factor. Accurate IOP measurement has a very important role in diagnosis as well as management of glaucoma.[1] Newer techniques and devices for determining IOP have been developed, such as the Tono-Pen, the ICare Tonometer, Dynamic Contour Tonometry, TGDc-01 Tonometry and the Ocular Response Analyser.[2] Goldmann Applanation Tonometry (GAT) is still the gold standard for the measurement of IOP. Central corneal thickness (CCT) has been an important and confounding variable for IOP readings measured by both GAT and Non-Contact Tonometer (NCT). This study was done to compare intraocular pressure readings by NCT and GAT across different ranges of IOP and to correlate them with CCT.

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Corresponding Author:
Dr. Nitin Batra,
Professor and HOD,
Department of Ophthalmology, CMC Ludhiana.
E-mail: nbatra2001@gmail.com
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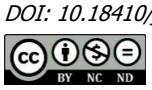

Aim

To compare IOP measured with Goldmann Applanation Tonometer (GAT) and Non-Contact Tonometer (NCT) and to evaluate the correlation between intraocular pressure measured by these two instruments with central corneal thickness (CCT).

MATERIALS AND METHODS

This was a cross sectional study conducted in the Department of Ophthalmology at Christian Medical College and Hospital, Ludhiana. A total of 256 patients (500 eyes) attending the outpatient clinic of Department of Ophthalmology, were enrolled in this study. Written informed consent was obtained from all patients who participated in the study.

Exclusion criteria were history of allergy to local anaesthetic, active ocular infection, subjects whose IOP could not be recorded due to any cause.

A careful and complete history of presenting complaints was taken. Past history of ocular disorder, glasses/contact lenses, surgery was recorded. Anterior segment and undilated fundus examination was performed. Three readings each for NCT and GAT were recorded and compared across three ranges of IOP- less than 12 mm Hg, 12-24 mm Hg and more than 24 mm Hg. CCT was measured in all patients. IOP measurements were done with NCT first followed by GAT to eliminate the reported possible effects of ocular massage by GAT.

IOP was recorded using NCT (NIDEK NT-510, Japan) and GAT (Haag Streit AG, 3098 Koeniz, Switzerland). CCT was measured using Pacscan 300AP USA. The eye was anaesthetized using Paracaine 0.5% eye drops for GAT and CCT measurements.

Statistical analysis was done by using Bland Altman analysis and paired t test. Limits of agreement were calculated. Student's t test and ANOVA were applied as the tests of association. Intraclass correlation coefficient, coefficient of repeatability and correlation coefficient were also calculated.

RESULTS

The study included a total of 256 patients (500 eyes) of which 47.26% were females and 52.73% were males. The mean age of the patients was 50.63 ± 15.69 years (range 18-85 years).

The mean IOP, as taken by NCT, was 16.06 ± 5.85 mm Hg and the range was 5.7- 58 mm Hg. The mean IOP measurement by GAT was 16.61 ± 6.94 mm Hg with a range of 6 - 66.3 mm Hg. The mean value of CCT was 527.36 ± 36.67 µm (range 423-649 µm).

Out of 500 eyes, GAT was equal to NCT in 12% (60) eyes. GAT was less than NCT in 36.20% (181) eyes and more than NCT in 51.80% (259) eyes. (Table 1.)

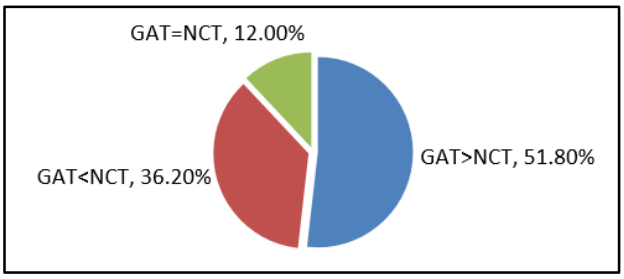

Table 1. Comparison of GAT and NCT

The difference between IOP readings of the two instruments was within ± 1 mmHg in 39% (195) eyes, within ± 2 mmHg in 25.20% (126) eyes, within ± 3 mmHg in 12% (60) eyes, within ± 4 mmHg in 6.40% (32) eyes and within ± 5mmHg in 1.80 % (9) eyes. 18 of 500 eyes (3.6%) showed a difference greater than ± 5 mmHg. (Table 2.)

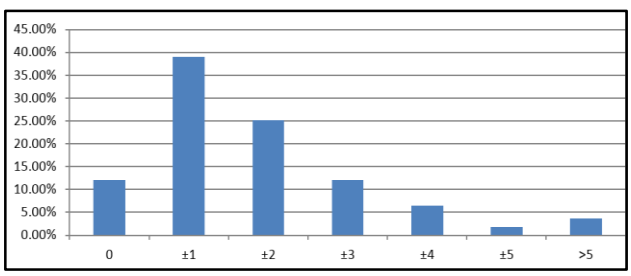

Table 2. The Difference between IOP Readings of GAT and NCT

Intraclass correlation of NCT was 0.9902 and for GAT was 0.9959. These results show that there is good repeatability for NCT and GAT over three readings.

It was clearly evident that in each case, the width of interval of GAT was less than NCT. Moreover, the mean difference and coefficient of repeatability was also less with GAT as compared with NCT. (Table 3.)

	Difference in Mean ± SD	Coefficient of Repeatability	Width of Interval
GAT 1-GAT 2	-0.09 ± 0.92	1.7942	3.5884
GAT 1-GAT 3	-0.11 ± 1.17	2.293	4.586
GAT 2-GAT 3	-0.02 ± 1.17	2.2859	4.5718
NCT 1-NCT 2	-0.11 ± 1.3	2.5451	5.0902
NCT 1-NCT 3	-0.23 ± 1.47	2.8869	5.7738
NCT 2-NCT 3	-0.12 ± 1.46	2.8544	5.7088

Table 3. Coefficient of Repeatability for GAT and NCT Readings

GAT 1- first IOP reading taken with GAT, GAT 2- second IOP reading taken with GAT, GAT 3- third IOP reading taken with GAT. NCT 1- first IOP reading taken with NCT, NCT 2- second IOP reading taken with NCT, NCT 3-third IOP reading taken with NCT.

17% (85) of the eyes were having IOP less than 12 mm Hg. Mean IOP in these eyes with GAT was 9.64 ± 1.27 mm Hg and with NCT was 10.61 ± 1.71 mm Hg. Limits of agreement ranged from -2.00 to + 3.90. The IOP readings of 74% (370) eyes were in the range of 12-24 mm Hg. Mean IOP in these eyes with GAT was 16.14 ± 2.97 mm Hg and with NCT was 15.67 ± 2.96 mm Hg. Limits of agreement ranged from -4.4 to + 3.50. 9% (45) of the eyes were having IOP more than 24 mm Hg. Mean IOP in these eyes with GAT was 33.62 ± 8.77 mm Hg and with NCT was 29.53 ± 8.06 mm Hg. Limits of agreement ranged from -10.00 to + 1.80. (Table 4.)

	Number of Eyes	Mean IOP with Gat	Mean IOP with NCT	Limits of Agreement
<12 mmHg	17% (85)	9.64 ± 1.27 mmHg	10.61 ± 1.71 mmHg	-2.00 - +3.90
12-24 mmHg	74% (370)	16.14 ± 2.97 mmHg	15.67 ± 2.96 mmHg	-4.4 - +3.50
>24 mmHg	9% (45)	33.62 ± 8.77 mmHg	29.53 ± 8.06 mmHg	-10.00 - +1.80

Table 4. Limits of Agreement for GAT and NCT Readings Over Various Ranges of IOP

In our study, IOP measured by both GAT (r=0.25, p=0.0001) and NCT (r=0.27, p=0.0001) positively correlated with CCT. (Table 5.)

	Correlation Coefficient	p Value	95% Confidence Interval
GAT	0.25	0.0001	0.1683 to 0.3326
NCT	0.27	0.0001	0.1837 to 0.3467

Table 5. Correlation Coefficient of NCT and GAT with CCT

We found that NCT and GAT correlated with CCT at values less than 510 µm and at values more than 530 µm. NCT correlated more with CCT. In eyes with CCT in range of 510-530 µm, both NCT and GAT did not show significant correlation. (Table 6.)

		Correlation Coefficient	p Value	Number
CCT ≤ 510 µm	NCT	0.16	0.03	156
	GAT	0.14	0.05	
CCT 510-530 µm	NCT	0.08	0.38	113
	GAT	0.09	0.18	
CCT> 530 µm	NCT	0.14	0.05	231
	GAT	0.11	0.06	

Table 6. Correlation of NCT and GAT at different ranges of CCT

DISCUSSION

The technique of measuring IOP and CCT are two important factors that influence IOP measurement. Both GAT and NCT are widely used methods and both are influenced by corneal properties. Goldmann based his concept of tonometry on Imbert-Fick law which calculates the IOP by measuring the force needed to flatten a constant corneal area. On the other hand, NCT uses a puff of air to deform the cornea and measures the time or force of the air puff that is required to create a standard amount of corneal deformation. NCT has certain advantages over GAT as corneal anaesthesia and staining of tear film is not required and infection risks are reduced.[3] GAT is commonly affected by corneal stiffness, thickness, scars, irregularities and curvature.[4] Insufficient flourescein use causes false low readings and excessive flourescein use causes false high readings. The presence of corneal epithelial defects and previous corneal surgeries also complicate the measurements.[5] There are other sources of error like thickness of mires, inability to be used in young children and physically disabled persons who cannot be positioned properly on slit lamp.[6] Finally, there is a contamination risk, so the tool tip must be cleaned after every use.[7]

One study done by Babalola et al from Africa found no significant difference between the two instruments but found that NCT was significantly affected by CCT.[8] A study done by Oguchi et al suggested that the NCT consistently gave higher readings.[9] However Yucell et al showed that the NCT records IOP lesser than GAT.[10] Tonnu et al showed that NCT underestimated in lower ranges and over estimated at higher IOP ranges.[11] Masumoto T et al have noted NCT to be minimally influenced by CCT.[12]

In the present study, NCT and GAT measurements showed good agreements for IOP less than 24 mm Hg, proving that both are reliable methods of measuring IOP.

Intraclass coefficient for both NCT and GAT was more than 0.9 showing good repeatability between the instruments. Coefficient of Repeatability for NCT and GAT was 2.7 mm Hg and 2.06 mm Hg respectively suggesting good test-retest repeatability for both devices.

Bland Altman test was applied to calculate 95% limits of agreement between NCT and GAT at different ranges of IOP. At IOP >24 mm Hg, the confidence limits ranged from -10.00 to + 1.80 mm Hg which were outside the clinically acceptable limits of agreement. In our study, NCT did not give comparable readings to GAT in patients with IOP >24 mmHg. There was also a significant correlation of IOP readings taken by both NCT and GAT with CCT and NCT correlating more with CCT (p value - 0.03 for CCT ≤510, p value - 0.05 for CCT>530).

CONCLUSION

Readings of NCT are clinically comparable with those obtained by GAT in population with IOP within normal range. NCT may be useful for screening in clinical settings but borderline high IOP readings should be confirmed with GAT. Intraocular pressure readings with GAT and NCT are affected by CCT, suggesting that CCT is an essential variable to consider in interpreting IOP readings, especially for the NCT measurements.

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