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A Comparison of NCT, Goldmann Applanation Tonometry Values in Diurnal Variability of Intraocular Pressure and their Relation to CCT in Healthy Subjects

Sudeshna Roy[1], Arkendu Chatterjee[2], Aritro Nandi[3]

[1]Assistant Professor, Department of Ophthalmology, Nilratan Sircar Medical College, Kolkata, India
Email-*sudeshnasen196[at]gmail.com*

[2]Associate Professor, Department of Ophthalmology, Nilratan Sircar Medical College, Kolkata, India

[3]Post Graduate Trainee, Department of Ophthalmology, Nilratan Sircar Medical College, Kolkata, India

Abstract: ***Objectives: To assess the difference of diurnal variation of Intraocular pressure (IOP) measurements obtained by Goldmann Applanation Tonometry (GAT) and Non-contact Tonometry (NCT) and to study their relationship to central corneal thickness (CCT) in non-glaucomatous eyes. Methods: This is a prospective study of 200 eyes of 100 non- glaucomatous subjects of age between 15yrs-80yrs who underwent Intraocular pressure measurements by GAT and NCT. Intraocular Pressure was measured at 8.00AM, 12.00noon, 4.00PM, 8.00PM by both GAT and NCT and diurnal variation was calculated. CCT readings were taken from both eyes of 100 subjects. The effect of CCT was correlated with the GAT and NCT intraocular pressure differences and as well as with diurnal IOP. Results: The mean age was 46.06 yrs. The mean diurnal IOP variations from 8am to 12noon, 8am to 4pm and 8am to 8pm by GAT were 1.09mm Hg, 1.15mmHg, 2.41mmHg and NCT were 1.15mmHg, 1.74mmHg, 2.60mmHg respectively. The average CCT was found to be 546.60µm. No statistical difference was observed between GAT and NCT in measuring diurnal variation. No significant correlation was observed among NCT, GAT, diurnal variation and CCT values. Conclusion: In non-glaucomatous eyes differences in diurnal IOP variations measured by GAT and NCT was not statistically significant and no correlation was observed with CCT. Hence NCT could be an alternative to GAT in measuring diurnal variation of Intraocular pressure in clinical practice.***

Keywords: Intraocular Pressure, Diurnal variation, Goldmann Applanation Tonometry, Non-contact Tonometry, Central Corneal Thickness

1. Introduction

Intraocular pressure (IOP) is still the only risk factor that can be altered in glaucoma therapy. Intraocular Pressure (IOP) is one of the basic parameters of ocular health and diseases. Thus precise measurement of IOP is essential for ophthalmologist assessment.

In clinical practice Goldmann Applanation Tonometry (GAT) is the gold standard and most widely used method for measuring IOP. However since their introduction, Non-contact Tonometers (NCT) have become well established in clinical practice.NCT is a rapid, simple and objective method of Intraocular pressure measurement that can be performed by ancillary staff without the use of corneal anaesthesia.

The accuracy of GAT may be influenced by Central Corneal Thickness (CCT). A thinner cornea may require lesser force to applanate, leading to underestimation of IOP while a thicker cornea would require more force thus giving an artificially high IOP reading.

Intraocular Pressure is subjected tocyclic fluctuations throughout the day. It has been noted that Intraocular pressure was typically highest at early morning and lowest at late evening and midnight. Mean fluctuation is less than 5mmHg. Greater than 5mmHgraises suspicion about glaucoma. The factors responsible for this are the cortisol levels which peaks in the early morning at 8am and lowest level at midnight.

The aim of the study was to assess significant difference in diurnal variation of intraocular pressure (IOP) measurement between Goldmann Applanation Tonometry and Non Contact Tonometry. In additional to which, central corneal thickness (CCT) affects measurements of diurnal variation of intraocular pressure by this two methods were also assessed.

2. Materials and Methods

This was a prospective comparative study involving 200 eyes from 100 subjects performed at Nilratan Sircar Medical College, Kolkata. The study was approved by the Ethics Committee ofNilratan Sircar Medical College. Written informed consent was obtained from each subject after full explanation of procedure.

Inclusion Criteria

1) Patients aged between 15 to 80 yrs of age.
2) Healthy individuals

Exclusion Criteria

1) Patients with a history of corneal disease, inflammatory eye disease

2) Patients with a history of eye surgery and ocular trauma
3) Patients with history of systematic disease (diabetes, pulmonary disease, cardiac disease etc.)
4) Patients unable to maintain fixation
5) Patients with astigmatism above 3 dioptres and above.

3. Technique

All procedures were explained to the subjects. After documenting patients particulars ophthalmic examination was done. IOP was measured at 8am, 12 noon, 4pm and 8pm by both Non-contact Tonometer and Goldmann Applanation Tonometer. Same instruments were used throughout the study and all the measurements were taken by a single experienced observer. Non-contact Tonometry was done by Computerised Tonometer TOPCON CT-IP in both eyes. Four measurements were taken and the average was taken for analysis. Twenty minutes later IOP was measured with GAT on Appasamy ref AATM-K001 device in both eyes. All measurements were done with patient in sitting position. The Applanation tip was cleaned with 70% alcohol before each examination. Proparacaine hydrochloride 0.5% drop was placed in inferior conjunctival fornix. Fluorescein strip was applied to inferior conjunctival fornix for few seconds and IOP was recorded. The average of three measurements was taken for analysis. CCT readings were taken a!ong with NCT in the same instrument TOPCON CT-IP during 8am ,12 noon, 4pm ,8pm and average of them were taken for analysis.

Statistical analysis was performed using software Medcalc-Version 18.10.2. Descriptive statistical analysis was performed to prepare different frequency tables and to calculate the means with corresponding standard errors. Paired t-Test was used to compare the means of diurnal variation of IOP by GAT and NCT and $p<0.05$ was taken to be statically significant. Pearson correlation coefficient was calculated to find out if any correlation existed between diurnal variation of intraocular pressure by GAT and NCT with CCT values.

4. Results

In the study population 56% were males and 44% females. Mean age of total population was 46.06yrs while the mean age of male population was 46.96 yrs and that of female population was 44.9 yrs.

IOP were measured 4 times during office hours. Mean IOP readings at 8am by GAT was 16.34±3.02 mmHg and by NCT was 16.685±3.01 mmHg with a p -value of 0.2539.

At 12 noon GAT was 15.25±3.01mmHg and NCT was 15.535±2.09 mmHg with a p- value of 0.3434.

At 4pm GAT was 14.725± 3.05 mmHg and NCT was 14.945±2.98 mmHg with a p-value of 0.466.

At 8pm GAT was 13.925± 2.99 mmHg and NCT was 14.08± 2.95 mmHg with a p -value of 0.8930

The difference between the two methods in measuring IOP was not statistically significant as p-value >0.05

Diurnal variation was calculated by subtracting the IOPs noted during 12 noon,4pm,8pm from IOP during 8am considering it as baseline.

Mean diurnal variation during 8am to 12 noon was 1.09mmHg by GAT and 1.15mmHg by NCT.

Mean diurnal variation during 8am to 4pm was 1.615mmHg by GAT and 1.74 mmHg by NCT.

Mean diurnal variation during 8am to 8pm was 2.415 mmHg by GAT and 2.605 mmHg by NCT.

Table 1: Comparison of Diurnal variation of IOP (8am-12noon)

Method	Sample size	Mean	Standard Deviation	Minimum	Maximum	P-Value
GAT	200	1.09	0.6195	-1.00	2.00	0.3474
NCT	200	1.15	0.6555	-1.00	3.00	

Student t-Test was done between GAT and NCT diurnal variation of Intraocular pressure during 8am to 12 noon. The difference between the two methods was not found to be statistically significant (p-value>0.05).

Table 2: Comparison of Diurnal Variation of IOP (8am-4pm)

Method	Sample size	Mean	Standard Deviation	Minimum	Maximum	P-Value
GAT	200	1.6150	1.2588	-2.00	5.00	0.3457
NCT	200	1.7400	1.3864	-2.00	4.00	

Student t-Test was done between GAT and NCT diurnal variation of intraocular pressure during 8am to 4pm.The difference between the two methods was not found to be statistically significant (p-value>0.05).

Table 3: Comparison of Diurnal Variation of IOP (8am To 8pm)

Method	Sample size	Mean	Standard Deviation	Minimum	Maximum	P-Value
GAT	200	2.4150	1.2927	-2.00	6.00	0.1575
NCT	200	2.6050	1.3887	-3.00	6.00	

Student t-Test was done between GAT and NCT diurnal variation of Intraocular pressure during 8am to 8pm. The difference between the two methods was not found to be statistically significant (p-value>0.05)

Table 4: Correlation of Diurnal Variation of IOP By GAT with CCT

Duration	Sample size	Correlation Coefficient (r)	Significance Level, P-value	95% Confidence interval
8am -12noon	200	0.076	0.28	-0.06 to 0.21
8am-4pm	200	0.074	0.29	-0.06 to 0.21
8am-8pm	200	0.119	0.09	-0.01 to 0.25

During 8am to 12noon the correlation coefficient between GAT and CCT was 0.076 which is very low and with p-value>0.05, it was statistically insignificant. Hence there was no correlation between diurnal variation of Intraocular pressure by GAT between 8am -12noon and CCT values.

During 8am to 4pm the correlation coefficient between GAT and CCT was 0.074 which is very low and with p-value>0.05, it was statistically insignificant. Hence there was no correlation between diurnal variation of Intraocular pressure by GAT between 8am -4pm and CCT values.

During 8am to 8 pm the correlation coefficient between GAT and CCT was 0.119 which is very low and with p-value>0.05,it was statistically insignificant. Hence there was no correlation between diurnal variation of Intraocular pressure by GAT between 8am-8pm and CCT values.

Table 5: Correlation of Diurnal Variation of IOP By NCT with CCT

Duration	Sample size	Correlation coefficient (r)	Significance Level, P-value	95% Confidence interval
8am-12noon	200	0.131	0.06	-0.01 to 0.26
8am-4pm	200	0.129	0.06	-.0009 to0.27
8am-8pm	200	,0.122	0.08	-0.016 to 0.26

During 8am to 12 noon the correlation coefficient between NCT and CCT was 0.13 which is very low and with a p-value>0.05, it was statistically insignificant. Hence there was no correlation between diurnal variation of intraocular pressure by NCT between 8am, -12 noon and CCT values.

During 8am to 4pm the correlation coefficient between NCT and CCT was 0.13 which is very low and with a p-value>0.05, it was statistically insignificant. Hence there was no correlation between diurnal variation of Intraocular pressure by NCT between 8am -4pm and CCT values.

During 8am to 8pm the correlation coefficient between NCT and CCT was 0.12 which is very low and with a p-value>0.05, it was statistically insignificant. Hence there was no correlation between diurnal variation of Intraocular pressure by NCT between 8am -8pm and CCT values.

5. Discussion

Intraocular pressure is one of the parameters to monitor glaucoma. Diurnal variation of Intraocular pressure above 5mmHg is considered suspicious and above 8mm Hg is diagnostic of glaucoma. Large variation in central corneal thickness may cause false estimation of Intraocular pressure resulting in misinterpretation.

This study compared the diurnal variation of Intraocular pressure by GAT and NCT and their correlation to CCT.

In this study population number of male patients are more than female patients reflecting the society background of our country where male seeks medical attention more frequently than female.

Mean CCT value in our study was found to be 546.60± 33.98 compared to 544.73 ±30.46 by Malik A et al[1].

Mean IOP readings at 8am, 12noon, 4pm, 8pm were slightly higher for NCT compared to GAT but there was no significant statistical difference between them. Schepens G, Babalola et al[2] also found no significant difference between NCT and GAT.

There was a decrease in mean IOP measured by both GAT and NCT throughout the day in our study. Similar results have also been noted by studies done by Hamilton et al[3]in their study.

In our study we found the mean diurnal variation from 8am to 8 pm to be 2.415mmHg by GAT and 2.605mmHg by NCT. Study done by Ch.Ghountis et al[4] recorded diurnal variation by GAT to be 1.9mmHg and NC2.1mmHg.They also found no statistically significant difference between the diurnal intraocular pressure variation by the two instruments.

Coefficient of correlation r, by Pearson analysis was very small during all three periods and p-value was found to be>0.05 for both instruments. During 8am to 8 pm time period our correlation coefficient was 0.11 at p>0.05 for GAT and 0.12 at p>0.05 for NCT which is statistically insignificant. So we could not find any statistical correlation between diurnal variation of intraocular pressure measured by GAT and NCT with CCT during any time of the day. Similar study done by Ch .Gountis et al [4] also found no statistical correlation between GAT and NCT diurnal IOP from 8am to 8pm with CCT.

There are some limitations to this study. Sample size of this study was relatively small and future studies with larger population will be appreciable. Moreover we excluded subjects with irregular astigmatism and thus our findings may hold true only for subjects with similar refraction characteristics.

6. Conclusion

In conclusion this comparative study showed no statistical difference among NCT and GAT in measuring diurnal variation of intraocular pressure during the aforesaid duration in non-glaucomatous eyes. In addition no significant correlation could be found among NCT ,GAT, diurnal variation and CCT values. Though GAT is the gold standard for measuring IOP its use is limited in corneal diseases while NCT being a non contact instrument is a better choice in such cases. Hence we recommend that NCT could be used interchangeably with GAT in measuring diurnal variation of Intraocular pressure in clinical practice.

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