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Influence of Central Corneal Thickness on Intraocular Pressure Measurements With The Pneumotonometer and Goldmann Applanation Tonometer

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ABSTRACT

To compare intraocular pressure (IOP) measurements of Goldmann applanation tonometer and pneumotonometer with respect to central corneal thickness in eyes with normal intraocular pressure. Comparative study. IOP was measured with an pneumotonometer(NCT) and Goldmann applanation tonometer(GAT) in random order in 164 eyes(82 patients) with normal intraocular pressure. Central corneal thickness (CCT) was measured using an ultrasonic pachymeter after all IOP determinations had been made. Right and left eyes were analyzed separately for statistical purposes. In corneas with varying CCT, IOP measured with pneumotonometer showed higher values with thicker corneas and lower values with thinner corneas compared to Goldman applanation tonometer. IOP measured with pneumotonometer showed a significant variation with respect to central corneal thickness when compared to Goldman applanation tonometer which is a more reliable method of IOP measurement. Still pneumotonometer can be used for screening purposes for large crowds, since it is faster and easier to record IOP. In patients with suspicious disc changes, IOP measurements have to be reconfirmed with GAT so that diagnosis of glaucoma is not missed.

Keywords: Intraocular pressure (IOP), pneumotonometer(NCT), Goldman applanation tonometer(GAT), central corneal thickness(CCT).

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INTRODUCTION

Glaucoma is one of the major causes of irreversible blindness in both developing & developed countries. Early detection and control of intraocular pressure plays an important role in prevention and control of blindness due to glaucoma. Screening of patients and recording of intraocular pressure in the outpatient department is still a standard procedure for early detection of glaucoma. Ocular hypertension is associated with increased risk of developing glaucoma and lowering of IOP has shown to lessen the progression of visual field loss.

Goldman applanation tonometer measures the IOP by pressure required to flatten 3.02sq. mm of cornea, whereas pneumotonometer measures IOP by area of cornea flattened by fixed pressure (puff of air). As shown by previous studies both instruments are affected by CCT. With the advent of LASIK, we face thinner corneas in our day to day practice. Hence CCT measurement becomes an accessory co-investigation in borderline IOP values and in suspicious disc changes for early detection of glaucoma. This study is done to evaluate the influence of central corneal thickness on pneumotonometer and Goldman applanation tonometer.

MATERIALS AND METHOD

This was a prospective randomized comparative study conducted at the Department of Ophthalmology, Saveetha Medical college, Thandalam, Chennai from July to December 2016 after getting approval from Institutional review board.

164 eyes from 82 normal patients in the age group 40 – 60 years who attended the outpatient department in our hospital were taken up for the study. Of 82 patients 32 were males and 50 were females. Patients with corneal disease like scars, degenerations, dystrophies and edema were excluded from the study. Known glaucoma patients and newly diagnosed glaucoma patients were excluded. Patients with normal IOP (10-20mmHg) were only included for the study.

All patients were anaesthetized by topical proparacaine and IOP measured randomly by both methods giving an interval of 2 minutes between the two instruments. Three readings were recorded and an average was taken. CCT was measured with the ultrasonic pachymeter after tonometer measurements had been performed.

RESULTS AND DISCUSSION

There was a total of 82 patients (164 eyes). 39% were males and 61% were females. The mean age was 51 years with a SD of 7. The intraocular pressures by GAT and NCT and corneal thickness values are listed in Table 1.

Table 1: Demographic and clinical data

Variable	N	Mean (95% C.I.)
GAT (mmHg)	164	14.5 (14.2, 14.8)
NCT (mmHg)	164	14.8 (14.3, 15.3)
CCT (micrometre)	164	524.8 (519.6, 530.1)

There was a significant correlation between NCT and GAT (Intra-class correlation, r=0.79. p<0.001). The median CCT value was 522µm. GAT and NCT were found to correlate well in all CCT ranges (Table 2)

Table 2: Correlation of tonometers in different corneal thickness group

CCT (µm)	GAT Mean (95% C.I.)	NCT Mean (95% C.I.)	ICC (p-value)
Entire group	14.5 (14.2, 14.8)	14.8 (14.3, 15.3	0.79 (<0.001)
≤ 518	14.4 (13.9, 14.9)	13.3 (12.8, 13.8)	0.79 (<0.001)
519 - 551	14.6 (14.1, 15.1)	15.2 (14.7, 15.8)	0.93 (<0.001)
552 - 569	14.8 (13.5, 16.1)	17.1 (15.8, 18.3)	0.98 (<0.001)
≥ 570	14.6 (14.0, 15.1)	17.9 (17.5, 18.3)	0.88 (<0.01)

The Bland Altman plot (Figure 1) shows good agreement between both methods of tonometry. Mean of the difference between GAT and NCT was 2.3 mmHg.

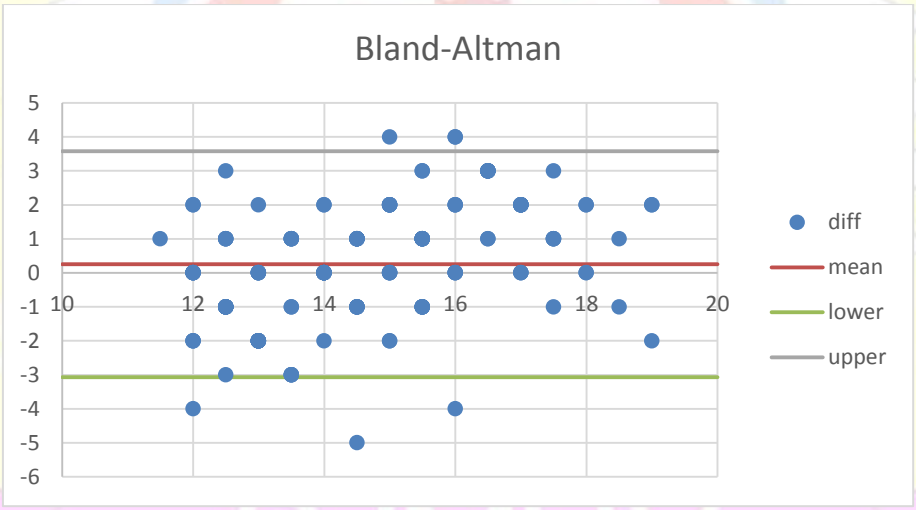

Figure 1: Bland Altman plot of the agreement between intraocular pressure measurements of Goldman applanation tonometer (GAT IOP) and non-contact tonometer (NCT IOP)

The 95% limits of agreement (Mean±1.96SD) were -3.1 mmHg to +3.6 mmHg. Intra-class correlation value between GAT and NCT was 0.79. There was a positive correlation with CCT with a regression of 0.05mmHg per 10µm for GAT and 0.7mmHG per 10 µm for NCT (Figure 2 and 3)

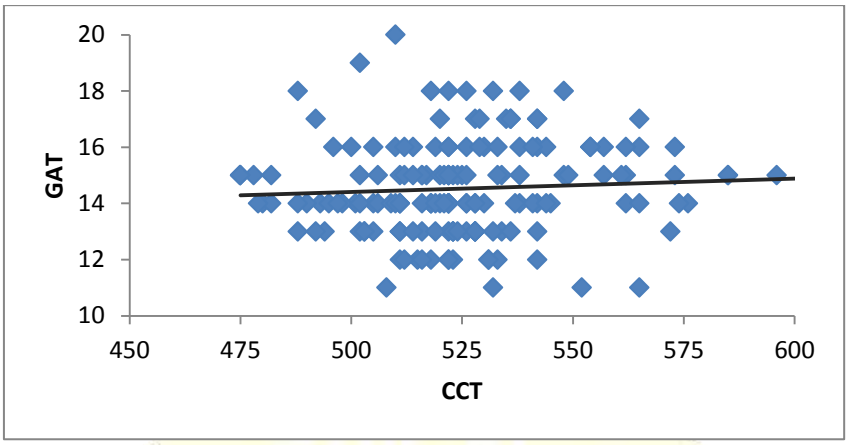

Figure 2: Linear regression plot for intraocular pressure measurement by Goldman applanation tonometer (GAT IOP) versus central corneal thickness (CCT)

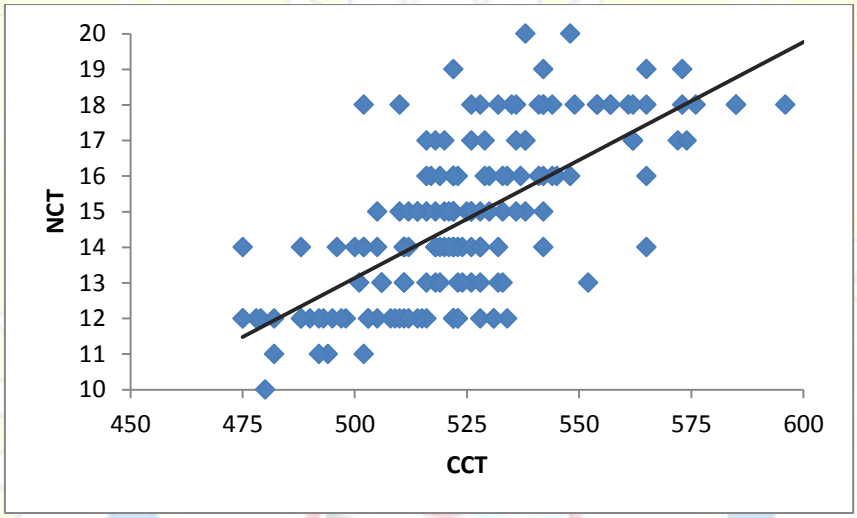

Figure 3: Linear regression plot for intraocular pressure measurement by Goldman applanation tonometer (NCT IOP) versus central corneal thickness (CCT)

DISCUSSION:

There are various methods by which intra ocular pressure measurement is done. In this study two methods (non-contact tonometer and applanation tonometer) are compared. Both methods are widely used for screening glaucoma. Central corneal thickness influences both the methods, but its influence on NCT was more than that for GAT. NCT and GAT measurements showed good agreements proving that both are reliable methods of measuring IOP. In past studies also, good agreement has been found with the correlation value ranging from 0.27 to 0.9 ($p=0.03$ to $p<0.001$).[1,3-8]

Table 2 shows the average values of NCT and GAT in varying corneal thickness. In corneal thickness, less than 518µm average GAT was 14.4mm hg and average NCT was 13.3mm hg. In corneal thickness, greater than 570 average GAT was 14.6mmhg and average NCT was 17.9mm hg. This proves that NCT is more influenced than GAT by central corneal thickness. This is similar to the study done by Chakrabarty L. et al[15]

In the present study, the 95% limits of agreement (Mean±1.96SD) were -3.1 mmHg to +3.6 mmHg. Intra-class correlation value between GAT and NCT was 0.79. There was a positive correlation with CCT with a regression of 0.05mmHg per 10µm for GAT and 0.7mmHG per 10 µm for NCT (Figure 2 and 3) which shows that GAT is a better method compared to NCT. This also proves that NCT is more influenced than GAT by central corneal thickness. [4 & 15]

In the past studies, there was no significance given as to how NCT and GAT values were recorded. In this study, care was taken to make a blind recording of both values by two experienced ophthalmologists and CCT values were recorded only after measuring the IOP by applanation and pneumotonometer. [7,8&10]

Also in this study, NCT values were found to be lower than GAT in thinner corneas and higher than GAT in thicker corneas showing that NCT was underestimated in thinner corneas & over estimated in thicker corneas. There was a positive correlation with CCT with a regression of 0.05mmHg per 10µm for GAT and 0.7mmHG per 10 µm for NCT which is similar to Chakrabarty L. et al[15] study.

Still pneumotonometer can be used for screening purposes for large crowds, since it is faster and easier to record IOP and does not require topical anaesthesia. In patients with suspicious disc changes, IOP measurements must be reconfirmed with GAT so that diagnosis of glaucoma is not missed. It also reemphasizes the importance of adjusting IOP readings according to individual corneal thickness to avoid intraocular pressure overestimation or underestimation, both of which could lead to wrong diagnosis and affect the assessment and clinical evaluation of glaucoma. [12,13&15]

Shortcomings in this study was that only patients with normal IOP range was included. The effect of CCT on higher ranges of IOP was not studied.

CONCLUSION:

In conclusion, Goldman applanation tonometer is a more reliable method of IOP measurement in all ranges of CCT while NCT shows a significant variation.

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