Correlation of Perkins Hand-Held Applanation Tonometer with Non-Contact Tonometer

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Abstract

Aim: To correlate the IOP by the use of Perkins hand-held applanation tonometer (PAT) with Non-contact tonometer (NCT). ***Materials & Methods:*** Prospective cross-sectional study done on 148 eyes & 3 readings were taken for each method & mean calculated. ***Statistical analysis:*** Unpaired-T test & Correlation-co-efficient, Sensitivity & Specificity were calculated for the NCT. ***Results:*** Mean age of subjects was 56.01± 9.73 yrs. Mean IOP with PAT & NCT 15.43 mmHg (95% CI 15.14–15.76) & 15.13 mmHg (95% CI 14.81–15.46) respectively. NCT shows excellent agreement with PAT. Correlation coefficient(r) of IOP measured by NCT & PAT is 0.97 & 0.91 for RE & LE respectively with p value <0.05, showed strong positive correlation between the IOP measured by NCT & PAT. The NCT showed high sensitivity 86% & high specificity 97.9 % respectively, coming across an excellent agreement with PAT. ***Interpretation:*** NCT is easy to operate (non medical & Paramedical staff), minimum risk of infection & without any observer bias. Only drawback is the cost. ***Conclusion:*** The current study shows that the NCT compares well with the PAT. The NCT can be used as a reliable screening tool.

Keywords: *Intraocular Pressure (IOP) ,Non-contact tonometer (NCT), Perkins applanation tonometer (PAT), Goldmann applanation tonometer (GAT), Right Eye (RE), Left Eye (LE).*

Introduction

Glaucoma is a chronic progressive optic neuropathy caused by a group of ocular conditions which lead to damage of the optic nerve with loss of visual function invariably associated with increased IOP. Diagnostic criteria of glaucoma Raised IOP, Classical Field Changes, Classical Optic disc changes Any 2 of the above present are sufficient to diagnose glaucoma. Epidemiology Glaucoma is a major cause of irreversible blindness in the world.[1] Globally, it is estimated that approximately 60 million people have glaucomatous damage & 8.4 million people who are blind as a result of glaucoma.[2, 3] The prevalence of glaucoma is projected to increase with population growth & the ageing of the population, & by 2020 it is expected that the number of affected people will have risen to 80 million. Even in developed countries, only half of the people with glaucomatous damage are aware of the diagnosis.[3] Early detection of glaucoma is crucial as effective & life long treatment for glaucoma prevents significant visual function loss.

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Material & Method

A hospital based prospective clinical trial was conducted with 74 patients to correlate the IOP by the use of PAT with NCT.

Inclusion criteria

- Patient between the age of 40-70 years.
- Corneal astigmatism < 3D & Refractive error < ±2D spherical.

Exclusion criteria

- Age < 40 years

- Corneal astigmatism > 3D.
- Diagnosed case of glaucoma, patients with scarred or hazy cornea.
- History of corneal surgery including refractive surgery.
- History of corneal disease like keratoconus, microphthalmos.
- History of ocular infection like uveitis, conjunctivitis, corneal infections.
- History of hypersensitivity to topical fluorescein..
- Pregnant or Breast feeding women.
- Patient not willing to participate in study

Study Design: Cross- Sectional Study

Source of Data: This study was conducted on patients attending outpatient department of ophthalmology in a tertiary care centre. It was conducted from **NOV 2017 to MAY 2019**. This study was approved from institutional ethics committee.

Methodology

Data was collected using a proforma, with the informed consent of the participants. A detailed history was obtained from each participant followed by routine ophthalmological examination including visual acuity testing, anterior segment & fundus examination. Both the procedures will be explained to the subjects & participants were subjected to two methods of tonometry & NCT readings were recorded first, then PAT. 3 readings were taken two by residents & one by paramedical personnel & mean was calculated. PAT was caliberated at weekly. Measurements of IOP will be taken from 9 AM to 5 PM to avoid the effect of diurnal fluctuations on IOP. No specific attempts was made to separate the population on basis of gender. Disinfection was done according to the American Academy of Ophthalmology recommended guidelines.

Sample size: 74 cases

Statistical Analysis:

Statistical analyses were performed using SPSS (statistical packages for social sciences) 20.0 for Windows, IBM, India. IOP measurements were compared to those obtained by the PAT which was assumed to be the gold standard(Sensitivity, specificity, positive & negative predictive values). Regression Analysis was also performed to determine any causal relationship (Dependant variable- PAT IOP; Independent variables- NCT , IOP, age & gender). A Bland– Altman plot was constructed by using excel new version to investigate the resistance of any systematic difference between the different tonometry methods. Data was analyzed using Diagrammatic presentation, Mean ± SD, Un-Paired t-test & correlation coefficient was calculated.

Results

Both the eyes of all included patients have been studied. Therefore, for this analysis background characteristics including various study groups were calculated based on standard sample size of 74 patients as per the sampling technique used, while the remaining analysis was based on 148 eyes. The analysis of data obtained showed that, from a total of 74 patients, 39(52.70%) were males & remaining 35(47.30%) were females. The average age of patients was 56.01±9.73 yrs. The mean of IOP measured by PAT & NCT was 15.43 mmHg (95% CI 15.14–15.76) & 15.13mmHg (95% CI 14.81–15.46) respectively**.** In this study the total participants were divided into 4 groups based on age for analysis purpose, as participants aged 41-50 yrs had 29(39%), 51-60 yrs had 21(28%), 61-70 yrs had 13(18%) & >or equals to 71 yrs had 11(15%) of participants.

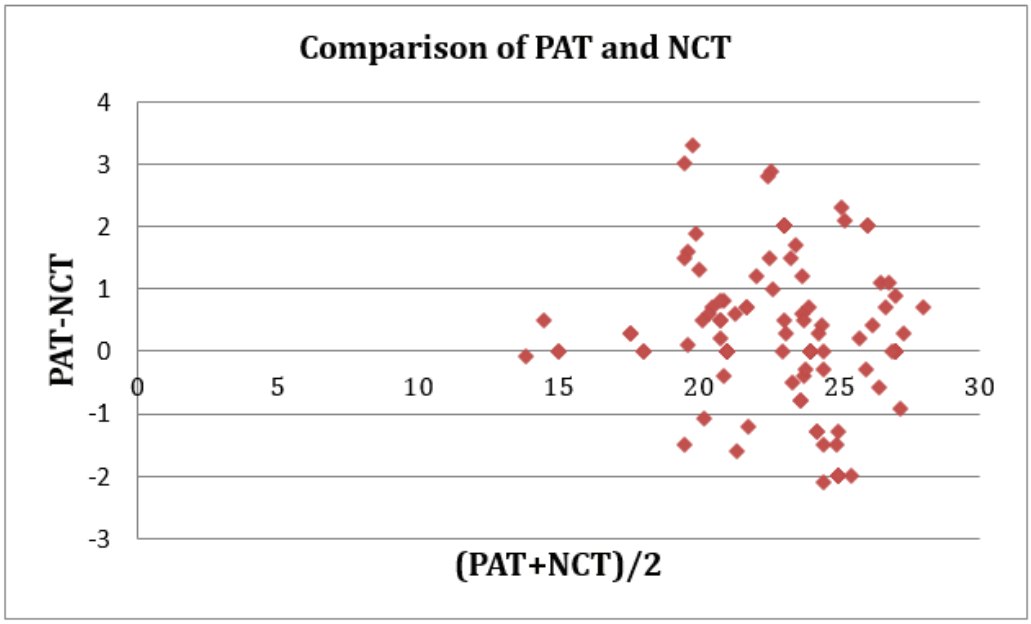
Table No. 1 shows that mean IOP in RE for both male & females in age groups of 41-50 yrs, 51-60yrs, 61-70yrs, >or equals to 71yrs with PAT & NCT were 15.66mmHg, 15.42mmHg, 15.69mmHg,14.73mmHg & 15.58mmHg, 15.2mmHg, 15.55mmHg, 14.5mmHg respectively for both tonometer with standard deviation of 1.6, 2.01,1.11,2.41 &1.75,2.03,1.01,2.5 with p values of 0.86,0.71,0.73,0.83 respectively, & it showed that there was no significant difference between two tonometer.

Table No. 1 shows that mean IOP in LE for both male & females in age groups of 41-50yrs, 51-60yrs, 61-70yrs, >or equals to 71yrs with PAT & NCT were 15.52mmHg, 15.43mmHg, 15.85mmHg ,14.55mmHg & 15.3mmHg,14.63mmHg,15.41mmHg,14.13mmHg respectively for both tonometer with standard deviation of 1.57,2.11,1.52,2.38 &1.91,2.48,1.54,2.7 with p values of 0.65,0.27,0.47,0.7 respectively, showed there was no

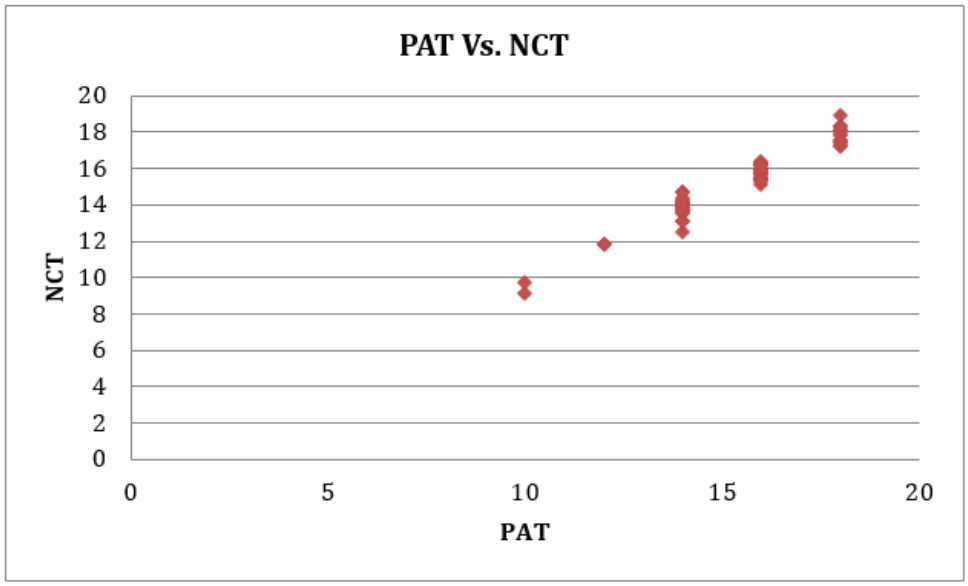
significant difference between two tonometer.

Table No. 2 shows that, age wise correlation of PAT compared well with the NCT for both eyes as evidenced by a r values of 0.97,0.99,0.86,0.99 with a p value <0.05 for RE & 0.91, 0.90, 0.95, 0.96 with a P value <0.05 for correlation, for both male & females in age groups of 41-50 yrs, 51-60 yrs, 61-70 yrs, >70 yrs respectively, showed extremely significant correlation between tonometer.

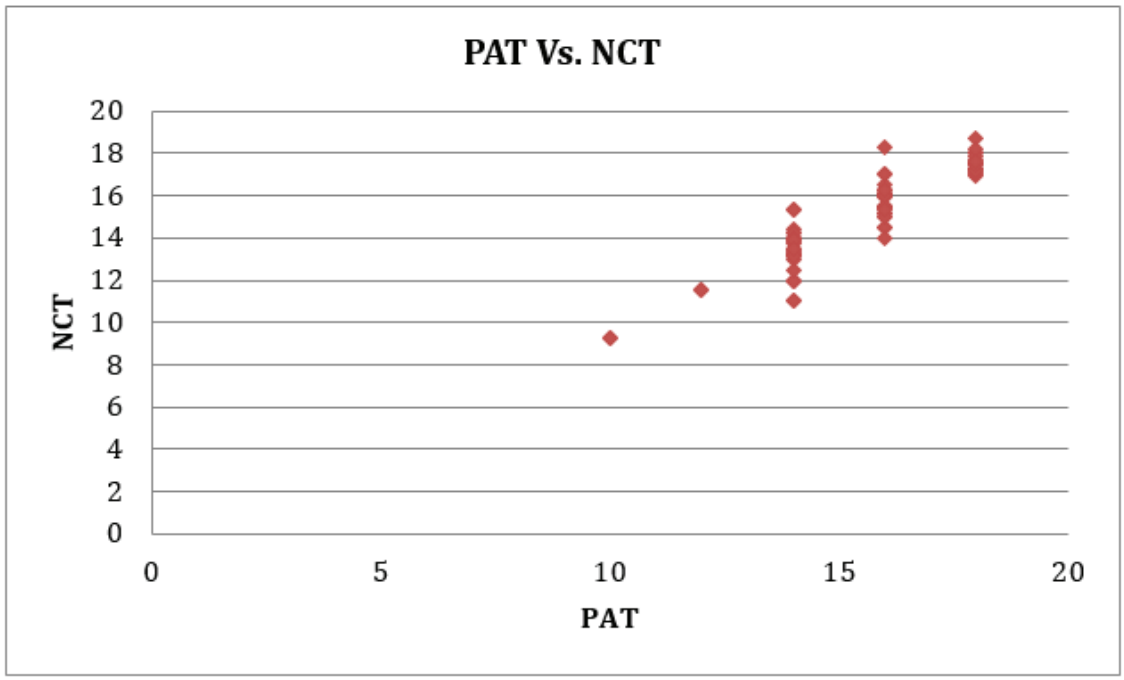
Table No. 3 shows, the correlation coefficient of IOP measured by PAT & NCT were 0.98 & 0.95 for RE & LE respectively with p value of <0.05 & were 0.97 & 0.88 for RE & LE respectively with p value of <0.05, showed strong positive correlation between the IOP among males & females & also it was shows, the correlation coefficient of IOP measured by PAT & NCT were 0.95 & 0.84 for RE & LE respectively with p value of <0.05 in our study participants showed strong positive correlation between tonometer.



Graph 1: Bland&-Altman Plot of Comparison of PAT & NCT.



Graph 2: Scatter Plot of RE IOP between PAT & NCT



Graph 3: Scatter Plot of LE IOP between PAT & NCT

Table 1: Mean IOP between PAT & NCT (in mmHg) among Total Participants by Age for both eyes.

Age (In Years)	Right eye					
	PAT		NCT		Unpaired t- Value	p value
	Mean	SD	Mean	SD		
41-50	15.66	1.6	15.58	1.75	0.18	0.86
51-60	15.42	2.01	15.2	2.03	0.37	0.71
61-70	15.69	1.11	15.55	1.01	0.35	0.73
≥71	14.73	2.41	14.5	2.5	0.22	0.83
Age (In Years)	Left eye					
	PAT		NCT		Unpaired t- Value	p value
	Mean	SD	Mean	SD		
41-50	15.52	1.57	15.3	1.91	0.46	0.65
51-60	15.43	2.11	14.63	2.48	1.12	0.27
61-70	15.85	1.52	15.41	1.54	0.73	0.47
≥71	14.55	2.38	14.13	2.7	0.39	0.7

Table 2: Age-wise Correlation Coefficient of IOP between PAT & NCT among total participants.

Eye	Age (In Yrs)	r value	r Squared	p-value
RE	41-50	0.97	0.94	<0.0001
	51-60	0.99	0.98	<0.0001
	61-70	0.86	0.74	0.0002
	≥71	0.99	0.99	<0.0001
LE	41-50	0.91	0.82	<0.0001
	51-60	0.90	0.80	<0.0001
	61-70	0.95	0.9	<0.0001
	≥71	0.96	0.92	<0.0001

Table 3: Gender wise Correlation Coefficient of IOP between PAT & NCT among total participants.

IOP	Method	Male			Female			Total		
		r value	r2	p value	r value	r2	p value	r value	r2	p value
RE	NCT	0.98	0.96	<0.0001	0.97	0.94	<0.0001	0.97	0.95	<0.0001
	PAT									
LE	NCT	0.95	0.9	<0.0001	0.88	0.78	<0.0001	0.91	0.84	<0.0001
	PAT									

Discussion

A hospital based prospective cross-sectional clinical trial was conducted with 74 patients to correlate the IOP by the use of PAT with NCT. In our study total participants were divided into 4 groups based on age for analysis purpose, as participants aged 41-51yrs had 29(39%), 51-60yrs had 21(28%), 61-70yrs had 13(18%) & >or equals to 71 yrs had 11(15%) of participants. This study was done with the principle aim to correlate the measurement of IOP by the NCT with the gold – standard PAT. According to a study by George R et al. [4] approximately 11.2 million Indians above 40 yrs suffer from glaucoma, supports our study to include all participants above the age of 40 yrs. [6-8]

The analysis of data obtained showed that, from a total of 74 participants, 39(52.70%) were males & remaining 35(47.30%) were females. The average age of participants was 56.01±9.73 yrs. Participants aged 41-50 yrs had maximum number 29(39%) of participants. In our study according to the Bland & Altman plot, the Mean (±S.D.) measurement for PAT was 15.44 mmHg (±1.83) compared with 15.13 mmHg (±1.87) for the NCT. The bias of the method was 0.30 (95% CI 0.14, 0.74) & precession was 3.78 (95% CI = 2.9, 4.67). Our study showed a good correlation between NCT & PAT when similar set of samples are used. In our study scatter plot for RE & LE showed positive correlation between NCT & PAT. In our study Mean IOP for RE was compared

between PAT & NCT which was 15.46 mmHg & 15.30 mmHg respectively with p value of 0.60, & for LE was compared between PAT & NCT was 15.41 mmHg & 14.96 mmHg respectively with p value of 0.18, showed that there was no significant difference between the IOP measured by the NCT & PAT & suggest very good agreement between PAT & NCT. These findings are comparable with a study done by Prabhakar SK et al.[5]

In our study Mean IOP for both male & females for RE in age groups of 41-50 yrs, 51-60 yrs, 61-70 yrs, >or equals to 71 yrs was compared between PAT & NCT & mean IOP was 15.66 mmHg, 15.42 mmHg, 15.69 mmHg ,14.73 mmHg & 15.58 mmHg, 15.2 mmHg, 15.55 mmHg,14.5 mmHg respectively for both tonometer with standard deviation of 1.6, 2.01, 1.11, 2.41 & 1.75, 2.03, 1.01, 2.5 with p values of 0.86, 0.71, 0.73, 0.83 respectively, & it was found that there is no significant difference between two tonometer which means there is very good agreement between two tonometer. These findings are comparable with a study done by Prabhakar SK et al.[5]

Mean IOP for both male & females for LE in age groups of 41-50 yrs, 51-60 yrs, 61-70 yrs, > or equals to 71 yrs was compared between PAT & NCT & mean IOP was 15.52 mmHg, 15.43 mmHg, 15.85 mmHg ,14.55 mmHg & 15.3 mmHg,14.63 mmHg,15.41 mmHg,14.13 mmHg respectively for both tonometer with standard deviation of 1.57, 2.11,1.52, 2.38 & 1.91, 2.48, 1.54, 2.7 with p values of 0.65,0.27, 0.47,0.7 respectively, it was found that there is no significant difference between two tonometer which means there is very good agreement between two tonometer.. These findings are comparable with a study done by Prabhakar SK et al.[5] It was observed in our study that Age wise correlation coefficient among the PAT, compared well with NCT for the REs, as evidenced by a r values of 0.97, 0.99, 0.86, 0.99 with a p value <0.05 for correlation, for both male & females in age groups of 41-50 yrs, 51-60 yrs, 61-70 yrs, >70 yrs respectively, showed extremely significant correlation between tonometer. & also shows that, Age wise correlation coefficient among the PAT, compared well with NCT for the LE as evidenced by a r values of 0.91, 0.90, 0.95, 0.96 with a P value <0.05 for correlation, for both male & females in age groups of 41-50 yrs, 51-60 yrs, 61-70 yrs, >70 yrs respectively, showed extremely significant correlation between tonometer.

It was observed in our study the gender wise correlation coefficient of IOP measured between PAT & NCT were 0.98 & 0.95 for RE & LE respectively with p value of <0.05 in males, showed strong positive correlation between the IOP measured by PAT & NCT among males & the gender wise correlation coefficient of IOP measured between PAT & NCT were 0.97 & 0.88 for RE & LE respectively with p value of <0.05 in females, showed strong positive correlation between the IOP measured by NCT & PAT among females. In our study the coefficient of determination of IOP measured by PAT & NCT were 0.95 & 0.84 for RE & LE respectively with p value of <0.05 & , showed strong positive correlation between the IOP measured by NCT & PAT amongst participants. These findings are comparable with a study done by Prabhakar SK et al.[5] An essential criterion for a good screening tool is high specificity & high sensitivity. The NCT has been shown to be a reliable screening tool by Shields & Moseley et al. [9] In our study Non-contact tonometer showed high sensitivity 82 (95%CL: 56.8-90.5) i.e. very few false negative results as well as high specificity 95.9 (95%CL: 92.7-99.1) i.e. few false positive results; thus coming across an excellent agreement with PAT. Our results are comparable with study done by Moseley M. J et al. & reported that NCT has sensitivity of 85% & specificity of 95%. [10] In our study Inter-observer variability more occurs with PAT while NCT records IOP automatically leading to less chance of observer bias which proves that the scope of change reading with NCT was very rare as compared to PAT. In our study 2 out 74 participants had conjunctivitis & 8 had epitheliopathy with PAT & no participants had conjunctivitis & epitheliopathy with NCT. Thus the NCT was found to compare well with the PAT & confirmed the finding of previous researchers Hsu et al. [11] & Ogbuehi & Almubrad.

Conclusion

Advantages of PAT are Portablility & is a choice of tonometer in bedridden patients. Disadvantages of PAT are Cooperation of patient is needed, Squeezing of lids can lead to falsly high readings, On successive reading can lead to applanation epitheliopathy, May spread infections like keratoconjuntivitis, Need for topical anaesthesia & fluorescein dye required for staining, Slow learning curve, scope of Inter observer bias is present. [12] Advantages of NCT are faster & reproducible results. Topical anaesthesia & fluorescein dye for staining not required. Non-contact technique (avoids infections like kerato conjuntivitis). No Inter-observer

Bias. Participant's acceptance for NCT is favorable and . with High Sensitivity & Specificity, makes it a reliabe tool for screening at tertiary eye care centre. Faster Learning curve can be used by paramedical personnel. Disadvantages are Expensive, Fixation is essential. The current study showed that, the NCT compares favorably with the PAT. NCT can be used as a reliable screening tool.

Ethical approval: All procedures performed on human participants were in agreement with ethical standards of the Institutional and/or National Ethics Committee.

Source of Funding: Self

Conflict of Interest: None.

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