Determination of Intraocular Pressure with the Perkins Applanation Tonometer and Non-Contact Tonometer

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ABSTRACT:

Early identification of GC is crucial, as studies have demonstrated, as successful and lifelong treatment for GC prevents significant visual function loss. This is why we chose to compare PA-TN with NC-TN readings for IOP in our study. Each patient had a complete opthalmological evaluation, beginning with a thorough h/o and ending with VA, AS and fundus tests. Two types of TN, known as NC-TN and PA-TN, were used on the patients. All patients with IOP between 10 and 21 were included, and first NC-TN and subsequently PA-TN values were collected. The mean was then determined from three separate readings, two from residents and one from a member of the support staff. In our study, for Relationship of IOP by NC-TN v/s PA-TN, we found that T15.46±1.8 and 15.30±1.87 for RE and NC-TN were 15.41±1.86 and 14.96±1.87 for LE, respectively. On the other hand, the average of PAT was 15.44±1.83 and the average of NCT was 15.13±1.87. Based on our analysis, it can be concluded that NC-TN has effectively exhibited its reliability as a screening tool.

INTRODUCTION

According to studies, glaucoma (GC) is a major cause of permanent blindness.[1] Additionally, studies have shown that "nearly 60 million people globally have GC damage, and 8.4 million people are blind as a result of the condition".[2] Numerous studies have shown an elevated incidence of GC, which is attributed to both population expansion and the advancing age of individuals.[3] Studies also concluded number of individuals afflicted by this condition have reached upto 80 million whereas, in wealthy nations, a mere 50% of those exhibiting glaucomatous damage possess knowledge of their diagnosis.[3] Researchers have noted that typical 24-hour diurnal fluctuations may be a potential RF for GC patients. This was due to the fact that changes in intraocular pressure (IOP) are more volatile and can have a more detrimental impact on the optic nerve in these individuals.[4] Studies also showed that the assessment and tracking of IOP hold significant significance in GC screening and management.[5] According to various studies, glaucoma, an advancing optic neuropathy, can be effectively mitigated through the implementation of measures aimed at reducing IOP.[5] Studies have shown that "tonometry(TN) is a standard procedure employed by ophthalmologists to measure IOP using a calibrated instrument".[6] Numerous studies have shown that the "device's usability and cost-effectiveness have a significant impact on the choice of TN for use in population screenings and rural camp settings for GC detection".[6] Hence, in our study, we have decided to correlate the measurement of IOP using a perkins articulation(PA) TN with a non-contact(NC) TN.

AIM

To correlate the measurement of IOP using a PA-TN with a NC-TN.

INCLUSION CRITERIA

1. Patient age between 40-70 years.
2. CNA< 3D.
3. RE <± 2D spherical.

EXCLUSION CRITERIA

1. Age < 40 years.
2. CNA >3D would be associated with an error of 1-2 mmHg.
3. Diagnosed case of GC, scarred or hazy cornea(HCN).
4. History of CN surgery including refractive surgery.
5. H/o CN disease like keratoconus, microphthalmos.
6. H/o inflammatory eye disease like acute painful eye.
7. H/o ocular trauma.
8. H/o OI like uveitis, conjunctivitis(C), corneal infection(CN-I),eye discharge(ED).
9. H/o hypersensitivity to topical fluorescein.
10. Patient started on corticosteroid therapy(CST).
11. Pregnant or breast feeding women (BFW).
12. Not willing to participate in study.

MATERIAL & METHOD

We have conducted a hospital-based prospective clinical cross-sectional study with a total of 74 patients starting in November 2017 and ending in May 2019 in the department of opthalmology in a tertiary care center. A detailed history was obtained from each patient, followed by routine opthalmological examinations, including VA testing, AS, and fundus examinations. Both procedures were explained to patients. Patients were subjected to two methods of TN, i.e., NC- TN and PA- TN. All patients within the range of IOP between 10 and 21 were included, and NC- TN readings were recorded first, then PA- TN was recorded. Three readings were taken by two residents and one by paramedical personnel, and the mean was calculated. (P) Applause TN was calibrated weekly. Measurements of IOP were taken from 9 a.m. to 5 p.m. to avoid the effects of direct fluctuation (DF) on IOP. No specific attempts were made to separate the population on a gender basis. The patients selected covered all age groups from 40 to 75 years. Disinfection was done according to American Academy of Opthalmology guidelines.

STATISTICAL ANALYSIS

SPSS version 20.0 was used for data analysis. IOP measurements by TN(PAT), Regression analysis using causal relationship, Abland Altman plot using the new version of Excel (difference between different TC methods). Mean ± SD, unpaired t-test, and correlation coefficient were calculated.

RESULT

Parameters	NCT Vs P-TN
Sensitivity	82% (95% CI: 56.8–90.5)
Specificity	95.9% (95% CI: 92.7–99.1)

Table 1: Non-contact TN v/s PTC

In our study, we found that the validity of the IOP measurements was high, and both NCT and P were found to have high specificity and sensitivity (Table 1).

Age (in years)	No. of Participants	Percentage
41-50	29	39%
51-60	21	28%
61-70	13	18%
≥71	11	15%
Total	74	100%

Table 2: Age-wise

In our study, we found that the total patients were divided into 4 groups based on age for analysis purposes: patients aged 41–50 years had 29 (39%) of patients, 51–60 years had 21 (28%) of patients, 61–70 years had 13 (18%) of patients, and more than or equal to 71 years had 11 (15%) of patients (Table 2).

Gender	No. of Participants	Percentage
Gender	39	53
Males	35	47

Table 3: Gender-wise

In our study, we found that,out of total of 74 patients, 39 (52.7%) were males and the remaining 35 (47.3%) were females. The average age of patients was 56.01±9.73 years (Table 3).

Age (in years)	No. of Male Participants	%	No. of Female Participants	%	Total No. of Participants	%
41-50	17	23	12	16	29	39
51-60	12	16	9	12	21	28
61-70	6	8	7	9.5	13	18
≥71	4	6	7	9.5	11	15
Total	39	53	35	47	74	100

Table 4: Age & Gender wise

In our study, we found that the maximum number of participants, i.e., 29 (39.0%), were in the 41–50 age group. 21 (28%) participants were in the 51–60 year age group, 13 (18%) participants were in the 61–70 year age group, and the remaining 11 (15%) participants were in the more than 70 year age group. The maximum number of participants were males, and the maximum number of participants were in the age group of 41–50 years (Table 4).

Intraocular Pressure	Method	Mean	SD	t - value	p value
	PAT	15.46	1.79	0.52	0.60
Right Eye	NCT	15.30	1.87		
	PAT	15.41	1.87	1.35	0.18
Left Eye	NCT	14.96	1.87		

Table 5: MIOP – PAT V/S NCT(Left Eye)(LE)

In our study, we found that the MIOP for the right eye with PAT and NCT were 15.46 mm Hg and 15.30 mm Hg, respectively, with a p value of 0.60, and the MIOP for the left eye with PAT and NCT were 15.41 mm Hg and 14.96 mm Hg, respectively, with a p value of 0.18. This showed that there was no significant difference between the intraocular pressure measured by the two instruments and suggested very good agreement between PAT and NCT(Table 5).

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

Table 6: Right eye(RE) (PAT V/S NCT)

In our study, we found that MIOP with PA- TN and NC-TN were 15.66 mm Hg, 15.42 mm Hg, 15.69 mm Hg, 14.73 mm Hg, and 15.58 mm Hg, 15.2 mm Hg, 15.55 mm Hg, and 14.5 mm Hg, respectively & standard deviation was 1.6, 2.01, 1.11, 2.41 and 1.75, 2.03, 1.01, 2.5 with p values of 0.86, 0.71, 0.73, and 0.83, respectively. Thus ,there was no significant difference between two TN, henceforth there was a good relation between two TN (Table 6).

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 7: LE

In our study, we found that MIOP with PA-TN and NC-TN were 15.52 mm Hg, 15.43 mm Hg, 15.85 mm Hg, 14.55 mm Hg, and 15.3 mm Hg, 14.63 mm Hg, 15.41 mm Hg, and 14.13 mm Hg, respectively and standard deviation was 1.57, 2.11, 1.52, 2.38 and 1.91, 2.48, 1.54, 2.7, and p values of 0.65, 0.27, 0.47, and 0.7, respectively, showed there was no significant difference between two TN , henceforth was a good relation between two TN (Table 7).

Eye	Age (In Years)	r value	r Square	p-value
	41-50	0.97	0.94	<0.0001
	51-60	0.99	0.98	<0.0001
Right eye	61-70	0.86	0.74	<0.0002
	≥71	0.99	0.99	<0.0001
	41-50	0.91	0.82	<0.0001

	51-60	0.9	0.80	<0.0001
	61-70	0.95	0.9	<0.0001
Left eye	≥71	0.96	0.92	<0.0001

Table 8: Correlation cofficient of IOP between PAT &NCT

In our study, we found that on right side of eyes, r values was 0.97, 0.99, 0.86, and 0.99 respectively & p value was <0.05 for both male and females in age groups of 41–50 years, 51–60 years, 61–70 years , and more than 70 years, respectively. Thus, there was an extremely significant correlation between TN in total .Furthermore, on left side

of eyes, r values was 0.91, 0.9, 0.95, and 0.96 & P value was <0.05 for both male and females in age groups of 41–50 years, 51–60 years, 61–70 years, and more than 70 years, respectively. Thus, showed an extremely significant relation for both TN in total (both male and female) (Table 8).

Intr aocu lar	Method	Male			Female			Total		
		r value	r^2	p value	r value	r^2	P value	r value	r^2	p value
Right eye	NCT									
	PAT	0.98	0.96	<0.0001	0.97	0.94	<0.0001	0.97	0.95	<0.0001
Left eye	NCT									
	PAT	0.95	0.90	<0.0001	0.88	0.78	<0.0001	0.91	0.84	<0.0001

Table 9: Correlation IOP between PAT & NCT

In our study, we found that the male r vlaue was 0.98 and 0.95, respectively, with a p value<0.05, which proved to be a strong positive relation. Further, when saw for female, the r values were 0.97 and 0.88 with a p value <0.05, so it was proved to have a strong relation between NCT and PAT measured by IOP, respectively. Finally,

on comparison with both male and female, the r values were 0.97 and 0.91 (right eye and left eye), with a p value <0.05. So, there is a strong positive correlation between IOP measured by NCT and PAT (male and female) (Table 9).

Groups	Males	Females	Total
Myopia(M)	23(31%)	17(23%)	40(54%)
Hypermetropia(HM)	9(12%)	9(12%)	18(24%)
Astigmatism(A)	7(10%)	9(12%)	16(22%)
Total	39(52%)	35(47%)	74(100%)

Table 10: Refractive status (RS)

In our study, we found that among the 74 (100%) study population, 40 (54%) had M refraction(R); among them, 23 (31%) were males and 17 (23%) were females. Also, 18 (24%) had HM-R; among them, 9 (12%) were males

and 9 (12%) were females, whereas while discussing A-R among 16 (22%), 7 (10%) were males and the remaining 9 (12%) were females (Table 10).

Tonometric Methods	Mean I. O. P (± SD)		
	Right Eye	Left Eye	Average
PAT	15.46±1.79	15.41±1.87	15.44±1.83
NCT	15.30±1.87	14.96±1.87	15.13±1.87

Table 11: Relationship of IOP by NC-TN v/s PA-TN

In our study, we found that 15.46±1.8 and 15.30±1.87 for RE and and NC-TN were 15.41±1.86 and 14.96±1.87 for LE respectively on the other hand average of PAT was 15.44±1.83 and average of NCT was 15.13±1.87 (Table 11).

Tonometric Methods/Statistics	Change in Readings by		
	Resident I (Mean±SD)	Resident II (Mean±SD)	Optometrist (Mean±SD)
PAT	15±4	14±2	14±4
NCT	14.6±0.8	14.6±0.8	14.6±0.7
Mean Difference	0.4	0.6	0.6
P-value	0.4	0.0178	0.2

Table 12: Change in reading among IOP measurement

In our study, we found that inter-observer variability more frequently occurs with PAT, while NCT records IOP automatically, leading to a lower chance of observer bias (Table 12).

Tonometric Methods	Infection due to handling		Infection Absent
	Conjunctivitis (C)	Epitheliopathy(E)	
PAT	2	8	64
NCT	0	0	74

Table 13: Infection due to heading

In our study, we found that 2 out of 74 participants had conjunctivitis, 8 had E with PAT, and no participants had C and E with NCT (Table 13).

DISCUSSION

The purpose of this study was to determine whether or not there was a correlation between the measurements of IOP taken using a NC-TN and those taken with a gold-standard PA-TN. A total of 74 participants between the ages of 40 and 75 participated in the study. According to a study conducted by "George R. et al., about 11.2 million Indians older than 40 years suffer from GC. This finding supports the inclusion of all participants older than 40 years in our study".[7] Due to the fact that IOP was the only modifiable RF in the progression of GC, IOP measurement has acquired significance and is now the mainstay of GC screening and follow-ups. [8,9] Studies have also proved that, "P-TN has the potential advantages of portability and not requiring a slit lamp. It is the preferred TN for bedridden patients, but it has the disadvantages of touching the C, staining with fluorescein, the risk of infection, the risk of CA, and the need for a skilled examiner".[10] In our study, we compared the MIOP for both males and females in different age

groups (41–50 years, 51–60 years, 61–70 years, and 71 years or older) between the PAT and NCT TN. The mean IOP values for the right eye were 15.66 mm Hg, 15.42 mm Hg, 15.69 mm Hg, and 14.73 mm Hg for the PAT TN, and 15.58 mm Hg, 15.2 mm Hg, 15.55 mm Hg, and 14.5 mm Hg for the NCT TN, respectively. The standard deviations were 1.6, 2.01, 1.11, and 2.41 for the PAT TN, and 1.75, 2.03, 1.01, and 2.5 for the NCT TN. The corresponding p-values were 0.86, 0.71, 0.73, and 0.83, respectively. Our findings indicate that there is no significant difference between the two TN, suggesting a high level of agreement between them. The results of this study are consistent with a previous investigation conducted by Prabhakar SK et al.[11] Both high specificity and high sensitivity are necessary qualities in an effective screening tool. This is one of the most important criteria. Both Shields and Moseley et al. have shown that the NC-TN is a trustworthy screening tool.[12] In our study, NC-TN showed a high sensitivity of 82 (95% CI: 56.8–90.5), which means that there were very few false negative results, and a high specificity of 95.9 (95% CI: 92.7–99.1), which means that there were extremely few false positive results. As a consequence, there was a good agreement between the NC-TN and Perkins applanation tonometer. Our results are consistent with those of a study carried out by Moseley, M. J., and colleagues, who showed that the NCT has a sensitivity of 85% and a specificity of 95%.[13] In our study, two participants out of seventy-four had C and eight patients had E with PAT, but no ptaitients had C or E with NCT. Thus, the NC-TN was found to compare well with the P-TN (a handheld version of the gold standard Goldmann's applanation TN), confirming the findings of previous researchers Hsu et al.,and Ogbuehi and Almubrad.[14]

CONCLUSION

Our investigation has demonstrated that the NC-TN exhibits a favorable comparison to the PA-TN, which is a handheld iteration of the esteemed Goldmann's A-TN, widely regarded as the gold standard. Furthermore, the NC-TN exhibits an exceptional level of agreement with the aforementioned device. Thus, NC-TN have demonstrated its efficacy as a dependable screening instrument.

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