To study the role of Non-contact Tonometry for measurement of intraocular pressure in patients attending ophthalmology outpatient department

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Introduction
The intraocular pressure is the fluid pressure inside the eye. It is the result of a dynamic balance between aqueous humour formation and outflow, which are nearly equal under normal conditions. Normal intraocular pressure varies between 10.5 to 20.5 mmHg with a mean pressure of 15.5 ±2.57mmhg (leydecker 1958). Intraocular pressure has an important role in case of detection of glaucoma, one of the most important cause of blindness worldwide. Ocular hypertension is associated with an increased risk of developing glaucoma and reducing intraocular pressure has shown to lessen progressive loss of visual field. Accurate and precise measurement of intraocular pressure is, therefore, fundamental to the management of glaucoma. Three types of tonometer are used clinically viz. Indentation, Applanation and Non Contact Tonometer. Schiotz, in 1905 developed prototype of indentation tonometer. The concept of applanation tonometry is based on Imbert Ficks law which states that pressure inside a sphere (P) is equal to the force (F) required to flatten its surface divided by the area of flattening (A) . P=W/A.
Goldmann in 1954 modernised this tonometer and currently it is the most popular and accurate tonometer. This device is mounted on a slit lamp bio microscope. The standard Goldmann tonometer falls somewhat short in the regard due to its requirement for a slit lamp (non portability), topical anaesthesia, fluorescein and an ophthalmologist. Bernard Grolman (1950) invented Non Contact Tonometer based on principle of applanation tonometer. Routine screening for glaucoma began with NCT.

Advantages of NCT: It doesnot require mechanical contact with the eyes, anaesthesia or eyelid retraction. It virtually eliminates professional skill and judgement as a factor influencing accuracy and reliability. NCT has the advantage that it reduces the possible risk of cross infection. Interpretation of result are easier than with GAT. NCT is a very fast, simple and rapid method for mass screening.

Material and Methods
This proposed study was conducted on 150 patients attending outpatient department for ocular examination at Upgraded Department Of Ophthalmology, Govt Medical College, Jammu and the cases were selected at random and enrolled in the study. Patients with age >20 years are included in the study.
Patients with BSCVA <3/60 and patients with history of severe dry eye syndrome, drug allergy (fluorescein, proparacaine), corneal abnormalities (corneal edema and scarring), ocular inflammation and infection, ocular trauma and recent ocular surgery(<3 months) were excluded from the study. Complete ocular examination including unaided visual acuity and the best corrected visual acuity with refraction was recorded. Anterior segment examination was done with slit lamp. Posterior vitreous, disc and macular examination were done by slit lamp biomicroscopy with 90D lens. The IOP measurement was taken with the subjects relaxed in seated position with both the eyes open. The mean of three consecutive readings per device were used for statistical analysis. The intraocular pressure assessment with the Goldmann applanation tonometer was subsequent to that with the non contact tonometer (CT-80) to prevent bias due to reduction of measured intraocular pressure caused by indentation or applanation.

The IOP was first measured with a non contact tonometer .The compressed air knob was cleaned before each measurement. Patient position was adjusted and the eyepiece reticule ring was brought to good focus and then three readings were taken with NCT (CT-80) in automode and average of three readings was taken to get the final result for each eye. After taking NCT measurements, applanation tonometry was performed with a gap of atleast 15 minutes. The probe of Goldmann applanation tonometer was cleansed with 70% isopropyl alcohol and dried. Maximum illumination with cobalt blue filter and 16 times magnification was adjusted in the slit lamp. The tonometer was set to the zero mark prior to the start of examination. The cornea was anaeasthetised with 0.5% proparacaine eye drops. The tear film was stained with 1% sodium fluorescein strip. The tip of the probe was advanced to approximate the cornea. The biprism splits the circle of contact into two semi circle mires. Adjustments were made to oppose the mires. Final readings were calculated by multiplying the reading on the knob by 10 to get the final IOP in mm of Hg. Three readings were averaged to get IOP for each eye. Antibiotic eyedrops were instilled in patients eye after the procedure was completed.

**Statistical Analysis**

The data was analysed using statistical software MS EXCEL and SPSS version 17.00 for windows. Main outcome variable was expressed as mean and standard deviation and its relationship was evaluated using correlation coefficient. Linear regression analysis was also performed to find prediction equation for IOP. A p value<0.05 was considered as statistically significant.

**Results**

The IOP measurements were taken with both types of tonometer on each patient. The difference of the means of NCT and GAT were taken and the results were compared in terms of accuracy. Following are the observations of our study:

**Table no. 1: Showing mean IOP and GAT in right eye of patients in different age groups.**

| AGE (YEARS) | NCT (RE) | GAT (RE) |
|-------------|----------|----------|
| 20-30       | 16.21    | 15.57    |
| 31-40       | 16.42    | 15.93    |
| 41-50       | 16.51    | 15.93    |
| 51-60       | 16.64    | 15.88    |
| >60         | 13.5     | 14       |

In our study, the NCT readings were higher than the GAT readings in all age groups.

**Table no.2: Showing mean IOP with NCT and GAT in left eye of patients in different age groups**

| AGE (YEARS) | NCT (LE) | GAT (LE) |
|-------------|----------|----------|
| 20-30       | 16.39    | 15.6     |
| 31-40       | 16.34    | 15.68    |
| 41-50       | 16.51    | 15.95    |
| 51-60       | 17.28    | 16.88    |
| >60         | 13.5     | 13       |

In our study, the NCT readings were higher than the GAT readings in all age groups.

**Table no.3: Showing mean IOP with NCT and GAT in right and left eye of 150 patients**

| EYE       | NCT (mm of Hg) | GAT (mm of Hg) |
|-----------|----------------|----------------|
| right     | 16.72          | 16.33          |
| left      | 16.78          | 16.37          |
In our study, mean IOP with NCT in right eyes of 150 patients was 16.72±1.94 mm of Hg and mean IOP with NCT in left eyes was 16.78±1.99mm of Hg.

Mean IOP with GAT in left eyes of 150 patients was 16.33±1.94mm Hg and mean IOP with GAT in left eyes was 16.37±1.99mm Hg.

**Fig .1:** Scatter plot showing correlation between the IOP measured with NCT and GAT in right eye of 150 patients.

The scatter plot showing a high positive linear relationship between IOP measurement obtained with NCT and GAT with a correlation coefficient of 0.954(t=38.00, p<0.0001)

**Fig . 2 :** Scatter plot showing correlation between the IOP measured with NCT and GAT in left eye of 150 patients.

Scatter plot showing a high positive relationship between IOP measurements obtained with NCT and GAT with a correlation coefficient of 0.947. (t=35.937, p<0.0001)
The proportion of eyes with GAT measurement of IOP <14 mm Hg detected by NCT was 18/22 (81.8%).

The proportion of eyes with GAT measurement of IOP between 14-20 mm Hg detected by NCT was 119/123 (96.7%).

The proportion of eyes with GAT measurement of IOP more than 20 mm Hg detected by NCT was 5/5 (100%).

**Table No. 4:** Showing total number of patients in different IOP range (right eye)

| S.No | IOP (mm Hg) | GAT | NCT |
|------|-------------|-----|-----|
| 1    | <14         | 22  | 18  |
| 2    | 14-20       | 123 | 119 |
| 3    | >20         | 5   | 5   |

**Fig. 3:** Scatter plot showing correlation between non-contact and Goldmann applanation tonometer in eyes (right) with IOP <14 mm Hg.

Scatter plot showing weak relationship between NCT and GAT in the IOP <14 mm Hg with a correlation coefficient of 0.697. (t=4.350, p=0.466)

**Fig. 4:** Scatter plot correlation between non-contact and Goldmann applanation tonometer in eyes (right) with IOP between 14-20 mm Hg.

Scatter plot showing positive relationship between IOP measurements obtained with NCT and GAT in the range 14-20 mm Hg with a correlation coefficient of 0.936. (t=29.21, p=0.006)
Fig. 5: Scatter plot showing correlation between non-contact tonometer and Goldmann applanation tonometer in eyes (right) with IOP >20mmHg

![Scatter plot showing correlation between non-contact tonometer and Goldmann applanation tonometer in eyes (right) with IOP >20mmHg](image)

Scatter plot showing no relationship between IOP readings >20mmHg obtained with NCT and GAT with a correlation coefficient of 0.078. (t= -0.191, p=0.134)

Table No.5: Showing total number of patients in different IOP range (left eye) with NCT and Goldmann applanation tonometry.

| S.no | IOP(mm Hg) | GAT | NCT |
|------|-----------|-----|-----|
| 1    | <14       | 23  | 18  |
| 2    | 14-20     | 119 | 115 |
| 3    | >20       | 8   | 8   |

The proportion of eyes with Goldmann Applanation Tonometry measurement of IOP <14mm Hg detected by NCT was 18/23(78%).

The proportion of eyes with Goldmann Applanation Tonometry measurement of IOP between 14 -20mmHg detected by NCT was 115/119(96.63%).

The proportion of eyes with Goldmann Applanation Tonometry measurement of IOP >20 mmHg detected by NCT was 8/8 (100%).

Fig. 6 : Scatter plot showing correlation between non-contact and Goldmann applanation tonometer in eyes (left) with IOP <14mmHg

![Scatter plot showing weak relationship between NCT and GAT in the IOP <14mm Hg with a correlation coefficient of 0.597](image)

Scatter plot showing weak relationship between NCT and GAT in the IOP <14mm Hg with a correlation coefficient of 0.597 (t= 3.407, p=0.0001).
Fig. 7- Scatter plot showing correlation between non-contact and Goldmann applanation tonometer in eyes (left) with IOP between 14-20 mmHg.

Scatter plot showing positive relationship between IOP readings obtained with NCT and GAT in the range between 14-20 mmHg with a correlation coefficient of 0.924. (t=26.230, p=0.004)

Fig. 8: Scatter plot showing correlation between non-contact tonometer and Goldmann applanation tonometer in eyes (left) with IOP >20 mmHg.

Scatter plot showing weak relationship in the IOP >20 mmHg between NCT and GAT with a correlation coefficient of 0.645. (t= 1.46, p=0.239)

**Discussion**

Elevated IOP is generally accepted as one of the most important risk factor for development of glaucoma. It is also known as the only modifiable risk factor for development of glaucoma. There are many tonometers available but Goldmann applanation tonometer is still considered the most accurate and dependable method for measurement of IOP. However the utility of NCT can’t be overemphasized in bigger hospitals catering to a large number of patients. Our study aimed to see the reliability of NCT for measurement of IOP as a screening tool and studied its correlation with the standard applanation tonometry.

For the purpose of statistical analysis we divided IOP readings in three subgroups taking GAT as
standard, to determine whether IOP level had any influence on the results.

Group 1: IOP < 14 mmHg
Group 2: IOP 14-20 mmHg
Group 3: IOP > 20 mmHg

Majority of the eyes were found to be in the less than 20 mmHg group, i.e., 96.6% eyes in the GAT group in the right eye and 94.6% eyes in left eyes.

Choi WJ et al (1990) in his study of reliability of NCT as a method of mass screening had majority of patients in IOP range of less than 21 mm Hg, i.e. 86.1% in GAT group and 88% in the NCT group. In our study mean IOP with NCT in right eye of 150 patients was 16.34±2.61 mmHg and mean IOP with NCT in left eye was 16.52±2.82 mm Hg. Mean IOP with GAT in right eye was 15.82±2.66 mmHg and mean IOP with GAT in left eye was 15.90±2.89 mmHg. The mean difference in IOP readings between two types of tonometry was 0.52±0.80 mmHg (RE) and 0.61±0.93 mmHg (LE) with the NCT readings returning higher than the GAT. The correlation coefficient (r) between the NCT and GAT in right and left eyes of 150 patients were 0.954 and 0.947 respectively and it is statistically significant (p<0.0001).

In the first group, the mean IOP difference was 1.04±0.89 mmHg and 1.30±1.10 mmHg for right and left eyes respectively and the correlation coefficient (r) was 0.697 (p<0.466) and 0.597 (0.0001) for right and left eyes respectively. In the second group, the mean difference in IOP was 0.39±0.69 mmHg and 0.41±0.77 mmHg for right and left eyes respectively and correlation coefficient (r) between NCT and GAT in right and left eyes were 0.936 (p<0.006) and 0.924 (0.004) respectively in the third group, the mean difference was 1.60±1.44 mmHg and 1.62±1.06 mmHg for right and left eyes respectively and the correlation coefficient (r) was 0.078 (p=1.134) and 0.645 (p=0.239) for right and left eyes respectively. Tonnu PA (2005) in his study of comparison of four methods of tonometry demonstrated that NCT had a tendency to underestimate the GAT at high IOP and underestimate the GAT at low IOP. Ogbuehi KC et al (2006), in a study of assessment of accuracy and reliability of Topcon CT 80 NCT with those of GAT on 60 right eyes of young healthy subjects with normal IOP found no statistically significant difference between the average IOP measured with the two techniques (p>0.05). the Topcon CT 80 NCT proved to be accurate and as reliable as the GAT in the assessment of IOP. Salim S (2009) in a study compared the measurements by the portable NCT PT100 with the GAT. The IOP measurements showed no significant difference in the measurements performed by the two tonometers (p=0.64). The findings of our study corroborates with the above mentioned studies.

Conclusion

NCT gives comparable results in normal pressure range (<20mmHg) with the NCT readings slightly higher than GAT. So NCT can be used as a screening procedure in tertiary care centres catering to a large no of patients wherein it is not possible to do GAT on all patients.

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