

## Original Article

# Comparative study of measurement of IOP with Goldmann's applanation tonometer and Non contact tonometer

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### Abstract :

**Aim :** The aim of this study is to validate the efficacy of NCT by comparing its measurements with that of Goldmann's applanation tonometry and to know if it can be used as a screening tool for glaucoma. **Materials and methods :** In 400 eyes of 200 adults selected for cataract surgery, IOP was measured first with NCT and 15min later with GAT and the results were compared. **Results :** The range of IOP measured was between 09 and 60 mm of Hg with NCT with an average of 17.01 mm of Hg where as it was between 8 and 54 mm of Hg with an average of 14.33mm of Hg with GAT. There were 51 eyes with an IOP of 22 or more with NCT while there are only 23 such eyes with GAT. (As per Z test,  $Z = 16.34$  which corresponds to  $(p < 0.001)$  indicates highly significant difference between GAT and NCT. **Conclusions :** The IOP measured was higher with NCT. With a cut off IOP of 22mm of hg, the numbers were more than double with NCT when compared to that from GAT. Hence NCT is not ideal for glaucoma screening /management and whenever the IOP reading was 22mm of hg or above, GAT should be performed.

**Key Words :** Intra ocular pressure, Goldmann's applanation tonometer, Non contact tonometer, Glaucoma

### Introduction

Glaucoma is an optic neuropathy of multivariate aetiology wherein intraocular pressure (IOP) is the most important and only modifiable risk factor.<sup>1</sup> The accurate IOP measurement has a very significant role in screening, diagnosis and management of glaucoma.

There are numerous types of tonometers available. However, Goldmann Applanation Tonometry (GAT) is still the gold standard for the measurement of IOP.<sup>2</sup> It is always important to validate other types of tonometers with GAT. The purpose of this study was to evaluate the role of non contact air-puff tonometer (Shin Nippon) by comparing the IOP measurements recorded using this device with those of GAT. If the results were comparable NCT can be more extensively used to measure IOP for screening of glaucoma and also for recording IOP in the outreach camps since NCT is more user friendly and the training needed is much simpler and shorter. It does not need other accessories like slit lamp, sterile Fluorescein strips etc. and can be very handy tool for screening.

### Materials and methods

This was a non-interventional, comparative study conducted between December 2014 and February 2015 at the outpatient department of Ophthalmology, Maharajah's

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Institute of Medical sciences, Vizianagaram. This study was conducted on 400 eyes from 200 patients of uncomplicated cataract,

Each patient's IOP was measured using both NCT, and GAT in that order, at an interval of 15 minutes by a single person using the same instruments to prevent any error due to inter personal, inter instrumental and diurnal variations

The IOP readings were tabulated and calculated to draw appropriate conclusions

### Inclusion criteria

All patients of uncomplicated cataract

### Exclusion criteria

(1) Any active eye disease – uveitis, corneal disease, infection, discharge, etc.

(2) Any other eye pathology that can either affect the IOP or its recording.

Both the procedures were explained to the subjects and an informed consent was taken.

### Methods

Measurement by NCT: This was done first in each patient followed by applanation tonometry lest it should effect the NCT readings

The measurements by the NCT were taken thrice, (as specified by the manufacturer), and the average of three measurements was taken.

Goldmann<sup>3</sup> in 1955 developed applanation tonometer on the principle of Imbert-Fick's law which states that flattening of a very small area of a fluid filled sphere can be done by a counter pressure exactly equal to the hydraulic pressure within the sphere without raising this hydraulic pressure and hence Goldmann applanation readings approach very close to the levels of pressure in the undisturbed eye.

Measurement by GAT: The time difference of at least 15 min was kept between recording IOP with NCT and GAT. The measurement with the applanation tonometry was done by a slit lamp mounted applanation tonometer on Haag-Streit R-900 device (Haag-Streit, Koeniz, Switzerland).

After explaining the procedure, the subject was seated comfortably at the slit lamp. Proparacaine (0.5%) eye drops were instilled as an anesthetic agent followed by application of sterilized strip of Fluorescein (1%) in the inferior fornix of the eye<sup>2,4-6</sup>. The applanation prism tip was cleaned to avoid transmission of infection.<sup>7</sup> The readings were taken by properly calibrating GAT. The standard clinical methods, recommendations and guidelines of the manufacturers were followed for appropriate readings<sup>8</sup>.

Non-contact tonometry was a user friendly invention which allows measurement IOP without anaesthesia. Noncontact (also called air-puff) tonometers do not touch the eye because they use a puff of air to flatten (applanate) the cornea. This method has the advantage that no topical anesthetic or risk of corneal abrasion is involved<sup>9</sup>. The system consists of a central air plenum flanked either side by a light emitter and a light detector. As the pressure of the air pulse directed to the cornea increases to deform the cornea, the corneal surface behaves like a plane mirror, reflecting light to the detector<sup>10</sup>. Corneal applanation is measured by collecting light reflected from the central cornea. A parallel beam of light is directed onto the central cornea at an angle of 30° and the reflected light is measured by a photo detector at an angle of reflection of 30°. The reflected beam of light will be strongest at this angle when the cornea is flat and acting as a plane mirror, rather than as a curved mirror. The instrument records the force of air required to flatten the cornea and displays the IOP that corresponds to that force. The Non-contact tonometer must be used at a set distance from the cornea, and the instrument incorporates an optical alignment system to facilitate this<sup>11</sup>.

## Results

The following results, obtained from the comparative study of IOP measurement by GAT and NCT are tabulated as under:

Table .1 Number of eyes under different ranges of IOP

Range	<9	10.-19	20-29	30-39	40-49	50-59	TOTAL
GAT	11	354	28	4	2	1	400
NCT	2	309	73	9	5	2	400

Most of the eyes have IOP recorded in the range between 10 to 19mm of Hg, with GAT (88.5%) and 77.25 % with NCT. 18.25% eyes with NCT and 7% with GAT had IOP in 20 to 29 range. The number of eyes with other IOP ranges is very small.

Table .2 Average IOP and mean deviation with GAT under different ranges

Range	<9	10.-19	20-29	30-39	40-49	50-59
Average	8.82	13.37	23	35	44	54
MD	0.38	0.97	0.89	3.32	4	0

Table .3 Average IOP and mean deviation with NCT under different ranges

Range	<9	10.-19	20-29	30-39	40-49	50-59
Average	9.35	14.78	22.1	34.13	45.4	58
MD	0.35	2.75	1.5	2.13	2.72	2

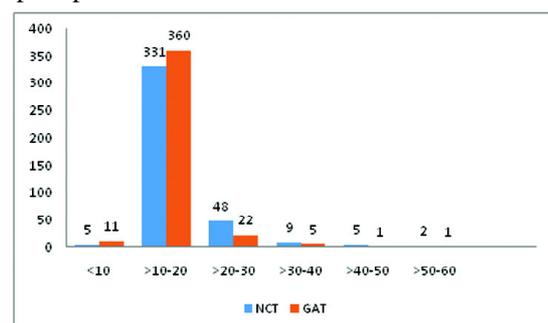
Table 4 Showing cut off IOP in the range of Glaucoma suspects

Range	<21	>21
AT	377	23
NCT	349	51

The tables number 2 and 3 reveal that the average IOP recordings were showing a variation of 1.41 between measurements with GAT and NCT where as the standard deviation is showing a difference of 1.78 under 10 to 19 range. Again fewer than 20 to 29 range of IOP, difference of average pressure is 0.9 and variation in the standard deviation is 0.61 respectively.

FIGURE 1

Graphic presentation of results.



## Discussion

The results of our present study show the measurement of IOP by NCT is consistently higher in all ranges of IOP irrespective of age, sex and laterality of the eye. It is also observed that the variation in the measurements by these two techniques is not significant in the lower range of IOPs, but there is a very significant difference in the number of eyes with IOP 22 or more (Cut-off for Glaucoma screening). With NCT 51 eyes had IOP 22 or more, while the number was 23 with GAT. When analysed with Z test,  $Z = 16.34$  which shows that it has p value of  $<0.001$ . Hence if NCT is used for glaucoma screening the number of False positives will be very high. Hence the authors feel that NCT is a good tool for screening and recording of IOP in the clinics but not of help for screening for glaucoma in the community.

The technique of IOP Measurement with NCT is easier and does not require much expertise as compared to that with GAT. Hence it may be used in the Out Patient. The results of our study are similar to that of the previous studies. The study done by Oguchi et al. suggested that the NCT consistently read higher reading<sup>[12]</sup>. Another study done by Moseley et al. also showed that at low IOP ranges the NCT tends to underestimate the readings whereas at high IOP ranges it tends to overestimate the IOP<sup>[13]</sup>.

## Conclusions

The measurements of IOP by NCT are consistently higher than those with GAT.

The number of patients with IOP of 22mmhg or more with NCT is almost more than double that with GAT. Hence NCT is not recommended for glaucoma screening lest there will be large numbers of false positives.

NCT can be used in the clinic for IOP screening since it is simple, user friendly and as its readings are a little higher, early glaucoma will not be missed.

Whenever the IOP recording is 22 or more with NCT, it should be checked with GAT.

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