

Content available at: <https://www.ipinnovative.com/open-access-journals>

IP International Journal of Ocular Oncology and Oculoplasty

Journal homepage: <https://ijooo.org/>

Original Research Article

Comparison of Goldmann applanation tonometer with Huvitz non-contact tonometer

Kritika¹, BK Gupta², Soni Tarun¹, Kanav Gupta^{1,2,*}¹NC Medical College and Hospital, Israna, Panipat, Haryana, India²Dept. of Ophthalmology, NC Medical College and Hospital, Israna, Panipat, Haryana, India

ARTICLE INFO

Article history:

Received 07-09-2023

Accepted 14-10-2023

Available online 06-11-2023

Keywords:

Glaucoma

intraocular pressure

Goldmann tonometer

Huvitz noncontact tonometer

ABSTRACT

Background: Glaucoma has been established as the second leading cause of blindness as blindness due to glaucoma is untreatable. Glaucoma screening is very important step to prevent visual loss and for screening intraocular pressure measurement plays an important role.

Aim: The study aims to compare the Goldmann applanation tonometer with Huvitz non-contact tonometer.

Material and Methods: This was a cross-sectional study conducted for a period of 3 months March 2023 to May 2023. 200 patients were included in the study taking care of exclusion criteria. The study was started after getting permission from the institutional ethics committee. Patients were randomly taken and they underwent NCT and GAT. The values of both were compared and analysis was done using STATA and SPSS software.

Findings: The study includes 200 patients who underwent GAT and NCT. The age group ranges from 21-45 years. The IOP values showed that the mean value in the GAT group was 15.54 mmHg and that in the NCT group was 17.255 mmHg. So, the mean value shows that the values obtained from NCT are higher than those obtained from GAT. The mean IOP in the NCT group is 1.715 mmHg higher than that in the GAT group. The study has a p-value of 0.001.

Conclusion: Both the above methods are frequently used for the measurement of IOP. NCT is an easy and less time-consuming method that is used more frequently. But the study concludes that the results of NCT are not as accurate and should be rechecked with those of GAT in cases with borderline values before starting workup of glaucoma.

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

It has been determined that glaucoma is the second most common reason for blindness.¹ In India, glaucoma ranks third among the leading causes of blindness. The fundamental goal of treating glaucoma is to reduce intraocular pressure (IOP), which slows or stops the disease progression and decreases vision loss while preserving patients' quality of life.¹⁻³

IOP is the term used to describe the pressure that the intraocular contents exert on the coats of the eye.⁴ The balance between production and drainage causes the aqueous humour to impose hydrostatic pressure on the intraocular tissues. IOP varies across people and even between the same person's eyes.⁵ In individuals with glaucoma, increased IOP is the only risk factor that can be altered, hence accurate measurement is crucial for managing the condition.^{6,7} In glaucoma patients, pharmaceutical and surgical treatments aiming at lowering IOP may successfully halt the deterioration of structural damage and visual field loss.⁸ IOP measurement using tonometry is

* Corresponding author.

E-mail address: kanavg@hotmail.com (K. Gupta).

therefore crucial for ophthalmological evaluation. The fact that glaucoma may advance despite IOP lowering to desired values suggests that variables other than IOP may be crucial in the pathophysiology of glaucoma.⁹

The mean IOP, as determined by pooled data from significant epidemiologic studies, is roughly 16 mmHg; however, these pooled data exhibit a non-Gaussian distribution with a skew towards higher pressures, particularly in people over the age of 40. In the past, 22 mmHg has been used to distinguish between normal and abnormal pressures as well as to identify patients who needed ocular hypotensive medication.^{10,11}

There are several ways to measure IOP, including contact methods (such as Goldmann applanation (GAT), Schiøtz Indentation, Rebound, and Dynamic Contour Tonometry) and non-contact methods (Air puff and Pulse air tonometry).¹²⁻¹⁵

The gold standard for measuring IOP is known as GAT, which is based on the Imbert-Fick law^{16,17} which states that the pressure inside of an infinitely thin, dry, smooth-walled, flexible sphere is equal to the external force needed to flatten the sphere's surface divided by the area flattened. It is made up of a double prism fixed to a typical slit lamp.¹⁸ Based on how much pressure is used to appliance the region, the IOP is measured.^{14,16,17}

The IOP is measured by non-contact tonometry (NCT) by blowing air into the cornea. The IOP is determined based on how long it takes for the cornea to become flattened by the air puff as its velocity increases.¹⁹⁻²¹ NCT is less complicated to perform, non-invasive, does not require prior anesthetic instillation, does not require Fluorescein staining, and is simple to perform, all of which contribute to increased comfort, reduced damage to the corneal surface, and a lower risk of contamination.²² It also takes less time to complete the procedure, with the added benefit of being useful for children.

The purpose of this study is to check the efficacy of NCT over GAT.

2. Materials and Methods

The study was a cross-sectional study conducted on patients who attended Ophthalmology OPD of a tertiary care hospital in the rural area of Panipat after taking ethical clearance. 200 patients were randomly taken for the study. The study was conducted for a period of 3 months from March 2023 to May 2023 in the Department of Ophthalmology at NC Medical College and Hospital, Israna.

2.1. Inclusion criteria

Patients above 20 years who attended Ophthalmology OPD and had given informed consent

2.2. Exclusion criteria

1. Patients with corneal opacity/ dystrophy/ degeneration.
2. Patients with any active eye disease like uveitis/corneal disease/infection/discharge.
3. Patients with keratoconus/ pterygium.
4. Patients who did not give informed consent.

A detailed history of all the patients above 20 years was taken. After taking history they underwent visual acuity testing followed by a thorough slit lamp examination. After that, they were randomly selected for study based on inclusion and exclusion criteria and they underwent NCT and GAT.

NCT was done first in every patient followed by applanation tonometry. It was finished before applanation tonometry since contacting the cornea by applanation prism could significantly affect NCT readings. The subjects were made to sit with chin contacting the chin rest and front head contacting forehead rest and IOP was estimated by the HUVITZ NCT (HNT1 2022 made in Korea). The readings by the HUVITZ NCT were taken three times and the average of three readings was taken as the final value since it has been found that HUVITZ NCT records the first reading higher.

The applanation tonometry was done by a slit lamp-mounted applanation tonometer on the Haag-Streit device. The subjects were made seated over the unit seat and the procedure was explained. Xylocaine eye drops were used as an anesthetic followed by the instillation of Fluorescein (1%) in the inferior fornix of the eye. The applanation prism tip was cleaned to keep away from transmission of disease and reading was taken by joining the inner ends of 2 mires. The value obtained was multiplied by 10 to get the final value.

After collecting data, the data were entered into a Microsoft Excel spreadsheet. The mean IOP was calculated for each instrument. Pearson's correlation coefficient was used to explore the correlation between the two methods of IOP measurements. The efficacy of the Huvitz tonometer was checked.

The study aims to compare NCT with GAT and to check which method is more reliable.

3. Results

Table 1: Shows the distribution of patients according to sex.

Sex	No. of patients
F	112
M	88

The Table 1 shows that the number of females taken in the study were 112 and the number of males was 88.

Table 2: Shows the distribution of patients according to age group.

Age group	No. of patients
21-25 years	38
26-30 years	39
31-35 years	24
36-40 years	42
41-45 years	57

The Table 2 that the maximum number of patients belong to the age group 41-45 years (57) followed by the age group 36-40 years (42). The minimum patients belong to the age group 31-35 years (24) followed by 21-25 years (38). The patients in the age group 26-30 years were 39.

Table 3: Shows the maximum and minimum values in both groups.

Value	GAT	NCT
Maximum	46	49
Minimum	10	11

It shows that the results of both groups are different.

Table 4: Shows the sum of all values in both groups and the mean of each group.

Parameter	GAT	NCT
SUM	3108	3451
Mean	15.54	17.255

The Table 4 that the sum of all values in the GAT group was 3108 and that in the NCT group was 3451. It also shows that the mean IOP in the GAT group was 15.54 mmHg and that in the NCT group was 17.255 mmHg. It shows a difference of 1.715 mmHg in the GAT and NCT groups. The NCT group shows a higher value than the GAT group.

The line graph shows that the value in the NCT group is higher than that in the GAT group hence the results of NCT can't be taken as final as they vary from gold standard GAT results.

Table 5: Showing distribution of patients according to their IOP value done by GAT.

IOP Range	No. of patients
10-19 mm Hg	186
20-29 mm Hg	10
30-39 mm Hg	1
39-49 mmHg	3

Table 5 shows the distribution of patients according to their IOP by GAT and it was seen that maximum patients lie within the range of 10-19 mmHg (186) which indicates that maximum patients were having normal IOP.

Table 6 shows the distribution of patients according to their IOP by NCT and it was seen that maximum patients

Table 6: Showing distribution of patients according to their IOP value done by NCT.

IOP Range	No. of patients
10-19 mm Hg	171
20-29 mm Hg	22
30-39 mm Hg	3
39-49 mmHg	4

lie within the range of 10-19 mmHg (171) which indicates that maximum patients were having normal IOP but with this technique, the number of patients lying out of normal range is more than that in GAT group.

Table 7: Showing the difference in readings of NCT and GAT.

Difference in NCT and GAT readings (NCT-GAT)	No. of Patients
0	25
1	81
2	63
3	23
4	4
8	1
9	1
13	1
21	1

Table 7 shows that 0 difference was present in 25 patients that is the value on GAT and NCT was the same. 81 had a difference of 1 in reading followed by 63 with a difference of 2 and 23 with a difference of 3. 4 patients had a difference of 4 among readings. Some patients were having large differences (8,9,13,21) in readings.

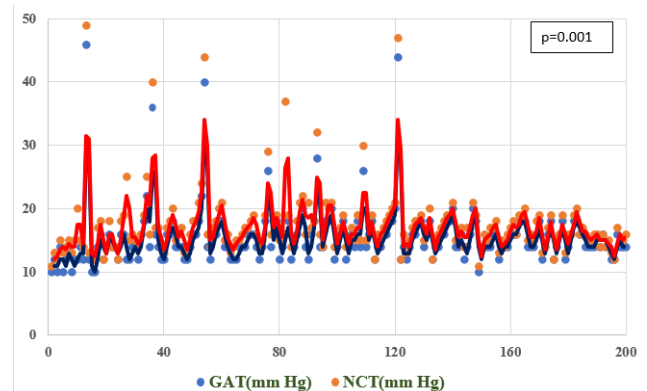


Fig. 1: Showing distribution of patients according to their IOP.

Figure 1 shows that there is a significant difference in IOP value done by both techniques. The values obtained by NCT are higher than that in the GAT group and hence NCT is not a reliable indicator for the diagnosis of IOP changes.

4. Discussion

Intraocular pressure is the measurement of the magnitude of the force exerted by aqueous humor on the anterior surface of the eye.²³ IOP plays an important role as if more pressure is exerted on the wall it can lead to adverse consequences. Measurement of IOP can be done by using tonometers. IOP measurement is necessary for the diagnosis and management of glaucoma and similar disorders. GAT is a gold standard technique for IOP measurement.^{16,17} On the other hand, NCT is an easy, non-invasive, and less time-consuming technique that is used widely.

The present study was conducted to evaluate the difference between IOP measurements taken by GAT and those taken by NCT. 200 patients were included in the study. In our study 112 were females and 88 were male. In our study, we found that there was a difference between the mean IOP among males and females with higher IOP in females. Similar to our results, Waheed et al performed a study on 100 males and 100 females with normal IOP and found that there was a statistically significant difference between mean IOP in females and males with that in females being on the higher side.¹ Jeelani et al also found that out of 50 males and 50 females above the age of 40 years with normal IOP values had a difference between the mean IOP in males and females, with higher IOP in females.²⁴

In the present study, we found significant differences between the IOP measurements of GAT and NCT with the mean IOP in the GAT group being 15.54 mmHg and that of the NCT group being 17.255 mmHg (p-value of 0.001). Similarly, Waheed et al also found that the mean IOP was 16.34 ± 2.3 mmHg for NCT and 14.48 ± 2.29 mmHg for GAT which shows a significant difference among both groups. Masood et al also found similar results in their study IOP was measured by GAT and PT100 NCT and the mean intraocular pressure was 16 ± 3.2 mmHg for GAT, and 16.58 ± 2.7 mmHg for PT 100 and it showed significant differences in results.¹⁹

As per our findings, we report that there is a significant difference between results by GAT and NCT, and hence to avoid error and to prevent misdiagnosis we should always confirm NCT value with GAT.

5. Conclusion

GAT and NCT both are widely used for screening and diagnosis of glaucoma. IOP can be measured by both techniques but in our study, we found that IOP measured by GAT is a more accurate and reliable source than NCT. NCT was seen to produce inaccurate and usually higher values. The disadvantage of GAT over NCT is that it is an invasive procedure, takes a long duration, and requires direct contact with the cornea, hence the chances of infections and abrasions increase. Where as NCT is a non-invasive quick technique. So, NCT can't be the ideal method for

calculating IOP. In cases where IOP value with NCT is highly raised, we must confirm them using GAT before prescribing medication.

6. Conflicts of Interest

None.

7. Source of Funding

None.

Acknowledgments

None.

References

1. Waheed M, Soliman TT, Attia TN, Basuony RE. Comparison of Intraocular Pressure (IOP) Measured by NonContact (Air-Puff) Tonometer Compared with Goldmann Applanation Tonometer. *BMFJ*. 2022;39:49-58.
2. Kass MA, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, et al. The ocular hypertension treatment study: A randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120(6):701-13.
3. Maurya RP. Glaucoma burden: Indian scenario. *Ind J Clin Exp Ophthalmol*. 2017;3(4):387-8.
4. Farhood QK. Comparative evaluation of intraocular pressure with an air-puff tonometer versus a Goldmann applanation tonometer. *Clin Ophthalmol*. 2013;7:23-7. doi:10.2147/OPTH.S38418.
5. Stock RA, Stroher C, Sampaio RR, Mergener RA, Bonamigo EA. A Comparative Study Between the Goldmann Applanation Tonometer and the Non-Contact Air-Puff Tonometer (Huvitz HNT 7000) in Normal Eyes. *Clin Ophthalmol*. 2021;15:445-51. doi:10.2147/OPTH.S294710.
6. Jacob C, Selvin S, Kuriakose T. Usefulness of the Non-Contact Tonometry in Out-Patient Screening. *Asian J Ophthalmol*. 2017;15:111-8.
7. Nucci C, Osborne NN, Bagetta G. Glaucoma: An Open Window to Neurodegeneration and Neuroprotection. vol. 173. Philadelphia: Elsevier; 2008. p. 25.
8. Nakamura Y, Ishikawa S, Nakamura Y, Sakai H, Hengan I, Sawaguchi S, et al. 24-hour intraocular pressure in glaucoma patients randomized to receive dorzolamide or brinzolamide in combination with latanoprost. *Clin Ophthalmol*. 2009;3:395-400.
9. Topouzis F, Founti P. Weighing in ocular perfusion pressure in managing glaucoma. *Open Ophthalmol J*. 2009;3:43-5. doi:10.2174/1874364100903010043.
10. Farhood QK. Comparative evaluation of intraocular pressure with an air-puff tonometer versus a Goldmann applanation tonometer. *Clin Ophthalmol*. 2013;7:23-7. doi:10.2147/OPTH.S38418.
11. American Academy of Ophthalmology. Practicing Ophthalmologists Curriculum: Glaucoma, basic and clinical science course; 2007-2008.; 2007.
12. Mohan S, Tiwari S, Jain A, Gupta J, Sachan SK. Clinical comparison of Pulsair non-contact tonometer and Goldmann applanation tonometer in Indian population. *J Optom*. 2014;7(2):86-90.
13. Kniestedt C, Punjabi O, Lin S, Stamper RL. Tonometry through the ages. *Surv Ophthalmol*. 2008;53(6):568-91.
14. Moraes CGV, Prata TS, Liebmann J, Ritch R. Modalities of Tonometry and their Accuracy concerning Corneal Thickness and Irregularities. *J Optom*. 2008;1(2):43-52.
15. Ahmad J, Khan MR. Muhammad Naeem Azhar, Tariq Mahmood Arainand Zaheer-ud-Din, Aqil Qazi. Accuracy of IOP Measured

- by Non-Contact (Air-Puff) Tonometer Compared with Goldmann Applanation Tonometer. *Pakistan J Ophthalmol*. 2014;30(1):1. doi:10.36351/pjo.v30i1.303.
16. Basaiawmoit JV, Arora T, Mishra SK. Tonometry: Guidelines for Glaucoma Investigations; 2012. Available from: http://proceedings.aios.org/aiosedu/uploads/Glaucoma-I_15.pdf.
 17. Goldmann H. Applanation Tonometry. In: Transactions Second Glaucoma Conference, New York. Josiah Macy, Jr Foundation; 1957.
 18. Khurana AJ, Khurana I. Anatomy and physiology of eye. vol. 2nd edn. New Delhi: CBS Publishers; 2006. p. 71–80.
 19. Shah MA, Saleem KB, Mehmood T. Intraocular pressure measurement: Goldmann Applanation Tonometer vs non contact airpuff tonometer. *J Ayub Med Coll Abbottabad*. 2012;24(3-4):21–4.
 20. Kim NR, Kim CY, Kim H, Seong GJ, Lee ES. Comparison of goldmann applanation tonometer, noncontact tonometer, and TonoPen XL for intraocular pressure measurement in different types of glaucomatous, ocular hypertensive, and normal eyes. *Curr Eye Res*. 2011;79(2):9–11.
 21. Moses RA. The Goldmann applanation tonometer. *Am J Ophthalmol*. 1958;46(6):865–9.
 22. Burr JM, Mowatt G, Hernandez R, Siddiqui MA, Cook J, Lourenco T, et al. The clinical effectiveness and cost-effectiveness of screening for open angle glaucoma: a systematic review and economic evaluation. *Health Technol Assess*. 2007;11(41):1–9.
 23. Machiele R, Motlagh M, Patel B. Intraocular Pressure. Treasure Island (FL): StatPearls Publishing; 2019. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK532237/>.
 24. Jeelani M, Taklikar R, Taklikar A, Itagi V, Bennial A. Variation of intraocular pressure with age and gender. *Natl J Physiol Pharm Pharmacol*. 2014;4(1):57–60.

Author biography

Kritika, Post Graduate Resident

Soni Tarun, -

Kanav Gupta, Associate Professor  <https://orcid.org/0000-0003-4119-4756>

Cite this article: Kritika, Gupta BK, Tarun S, Gupta K. Comparison of Goldmann applanation tonometer with Huvitz non-contact tonometer. *IP Int J Ocul Oncol Oculoplasty* 2023;9(3):117-121.