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Original Research Article

Comparative Study of Intraocular Pressure Measurements by Goldmann Applanation Tonometer and Schiotz Tonometer and the Study of Schiotz Tonometer as a Screening Tool

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Conflict of interest: Nil

Abstract:

Background: Intraocular pressure is an important measurement that needs to be taken during ophthalmic examinations, especially in ocular hypertension and glaucoma patients. Numerous tonometers have been proposed but ideal, reliable, accurate technique is required for early diagnosis.

Method: 90 patients with IOP were subjected to two methods of tonometry Goldmann applanation tonometry and Schiotz indentation tonometry (with 5.5 g, 7.5 g, and 10 g weights). Three recordings were obtained with each method, and significant results were noted.

Results: The Goldmann applanation tonometer showed fair agreement with Schiotz tonometer and proved to be an effective screening tool.

Conclusion: The Goldmann applanation tonometer was proved to be a better and safer tool for screening the IOP. It is much better than the Schiotz tonometer at predicting, measuring, and diagnosing intraocular pressure.

Keywords: Schiotz indentation tonometer, Goldmann applanation tonometer, screening tool, glaucoma, IOP.

Introduction

Intraocular pressure (IOP) defines as the fluid pressure inside the eyeball. In glaucoma patients and ocular hypertension patients, measurement of the intraocular pressure (IOP) is mandatory for any ophthalmic examination [1]. IOP is one of the most important modifiable risk factors which lead to glaucomatous damage to optic nerve [2]. So IOP is the best target for management of glaucoma. For diagnosis and management of glaucoma accuracy in the measurement of IOP is utmost priority to predict the severity of disease.

Glaucoma is the second leading cause of irreversible blindness globally. The risk of development of glaucoma increases with increase in intraocular pressure (IOP) [3].

The production of aqueous humour and its outflow across the globe generates pressure which is defined as intraocular pressure (IOP). IOP is measured indirectly via non-invasive method as the trans-corneal pressure gradient to detect glaucoma.

The latest techniques are Goldmann applanation tonometer and Schiotz tonometer. Aim is to study the IOP of patients by both techniques to evaluate the ideal and accurate IOP technique because chronic glaucoma has poor prognosis [4].

Material and Method

90 (ninety) patients who regularly visited the ophthalmic department of Al-Falah School of Medical Sciences and Research Center, Dhauj, Faridabad, Haryana-121004, were studied.

Inclusive Criteria: Patients above 40 years of age who gave their consent for the study were selected for the study.

Exclusion Criteria: Patients already on anti-glaucoma treatment, scarred or hazy cornea, patients who have undergone previous corneal surgery including refractive surgery, microphthalmos, blepharospasm, manifest nystagmus, keratoconus, or patients having corneal infections.

Method: The detailed ocular examination included visual acuity with or without a pinhole, which will be taken with the help of the Snellen chart for literate patients and the C chart for illiterate patients. Retinoscopy and auto-refractometry will be used to find refractive error. The conjunctiva, sclera, cornea, iris, pupil, anterior chamber, lens, posterior

chamber, and posterior segment were examined. Each patient was then subjected to two methods of tonometry. Goldmann applanation tonometry and Schiotz indentation tonometry under topical anesthesia with proparacaine eye drops (0.5%). First the readings were measured using the Goldmann applanation tonometer, followed by the Schiøtz indentation tonometer. Three consecutive readings were taken for each eye by each method, and the average calculated will be taken as the intraocular pressure. The prescribed procedures of Goldmann tonometry and Schiotz indentation tonometry were carried out on every patient, and the obtained results were noted and compared. The duration of the study is March 2024 to May 2025.

Statistical analysis: Various parameters of intraocular pressure were carried out with both Schiotz indentation tonometry and Goldmann applanation tonometry and were compared with t-tests and correlative coefficient methods, and significant results were noted. The statistical analysis was carried out in SPSS software. The ratio of male and female was 2:1.

Figure 1. Schiøtz tonometer with different weights.

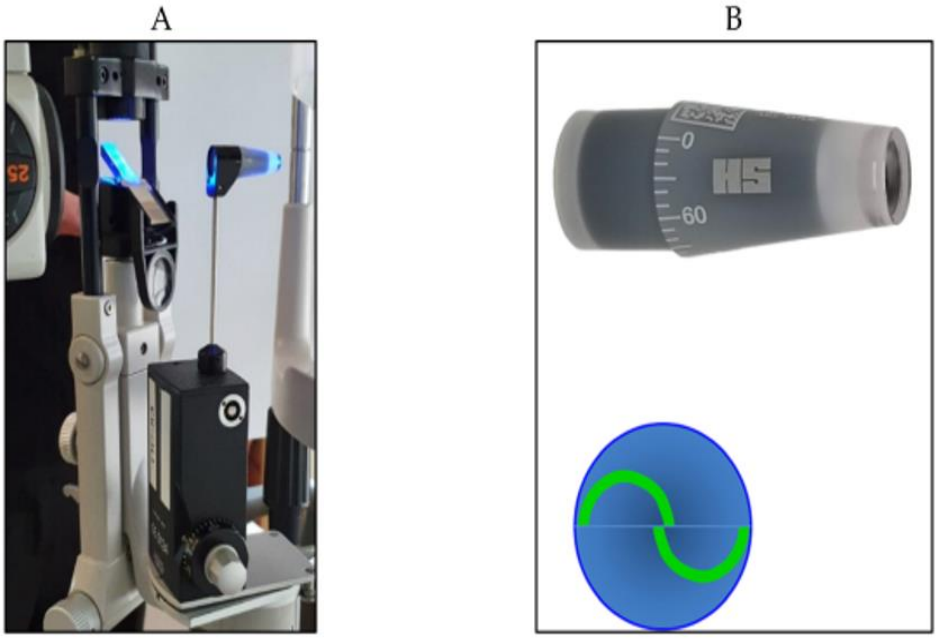

Figure 2. Goldmann applanation tonometer positioned on the slit lamp (**A**) with its cone prism (**B**) (on the top right); the two arcs appear correctly aligned (**B**) (on the bottom right).

Observation and Results

Table-1: Age wise distribution of patients - 47 (52.2%) were aged between 40-50 years old, 24 (26.7%) were aged between 51-60 years, 13 (14.4%) were between 61-70 years, 4 (4.4%) were aged 71-80, 2 (2.2%) were aged >80 years

Table-2: Correlation of GAT and Schiotz Tonometer

- ST–5.5 gm V/s GAT r=0.320 and p<0.001
- ST–7.5 gm V/s GAT r=0.358 and p<0.001
- ST–10 gm V/s GAT r=0.424 and p<0.001

Table-3:

Comparison of specificity and sensitivity in GAT and Schiotz tonometer -

- ST had 50% specificity, 94.2% sensitivity, 80% PPV, 88.3% NPV
- GAT had 53% specificity, 96.2% sensitivity, 82.5 PPV and 90.6% NPV.

Table 1: Age wise distribution of patients

Age groups in years	Number of patients	Percentage (%)
40-50	47	52.2
51-60	24	26.7
61-70	13	14.4
71-80	4	4.4
>80	2	2.2
Total	90	100

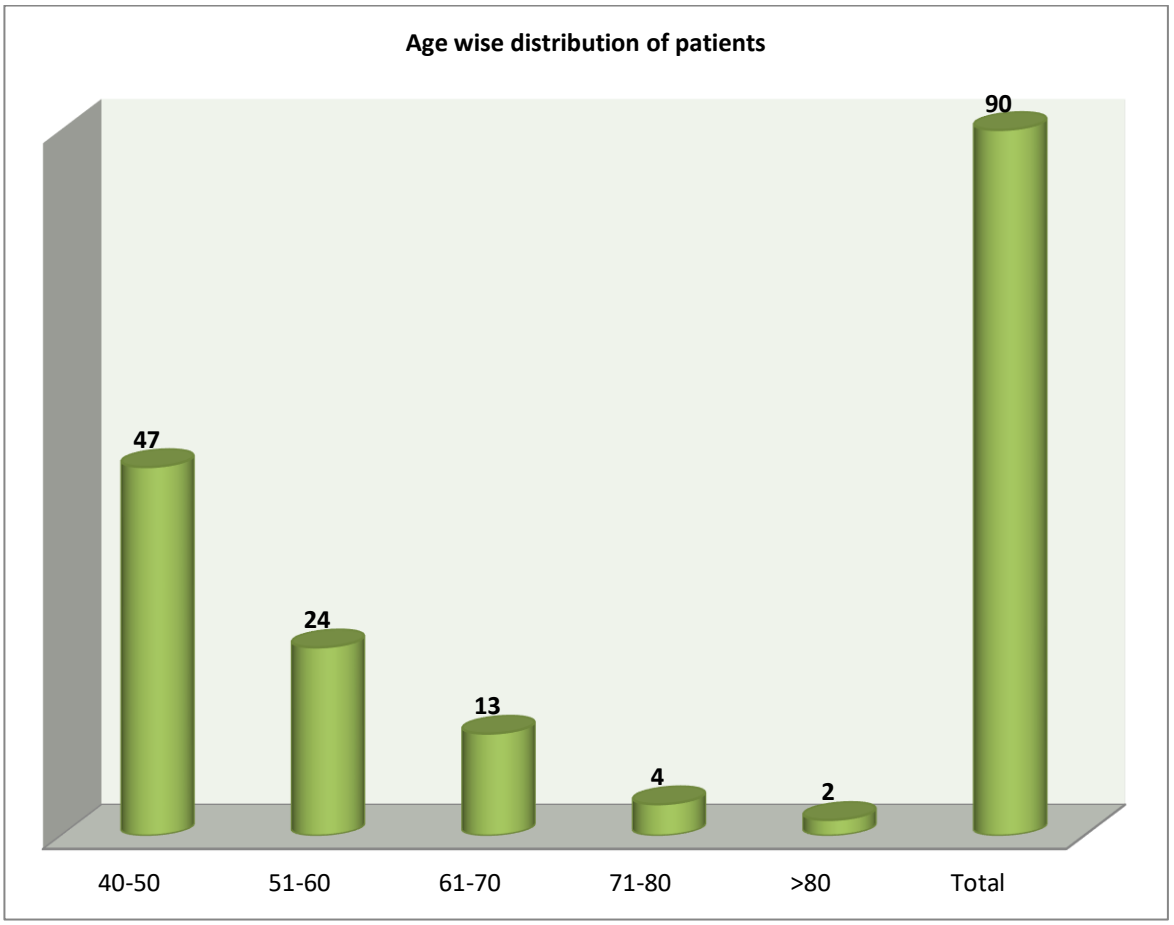

Figure 3: Age wise distribution of patients

Table 2: Correlation of Schiotz and GAT Tonometer

Correlation	Correlation coefficient	p value
ST–5.5 gm v/s GAT	r=0.320	P<0.001
ST–7.5 gm v/s GAT	r=0.358	P<0.001
ST–10 gm v/s GAT	r=0.424	P<0.001

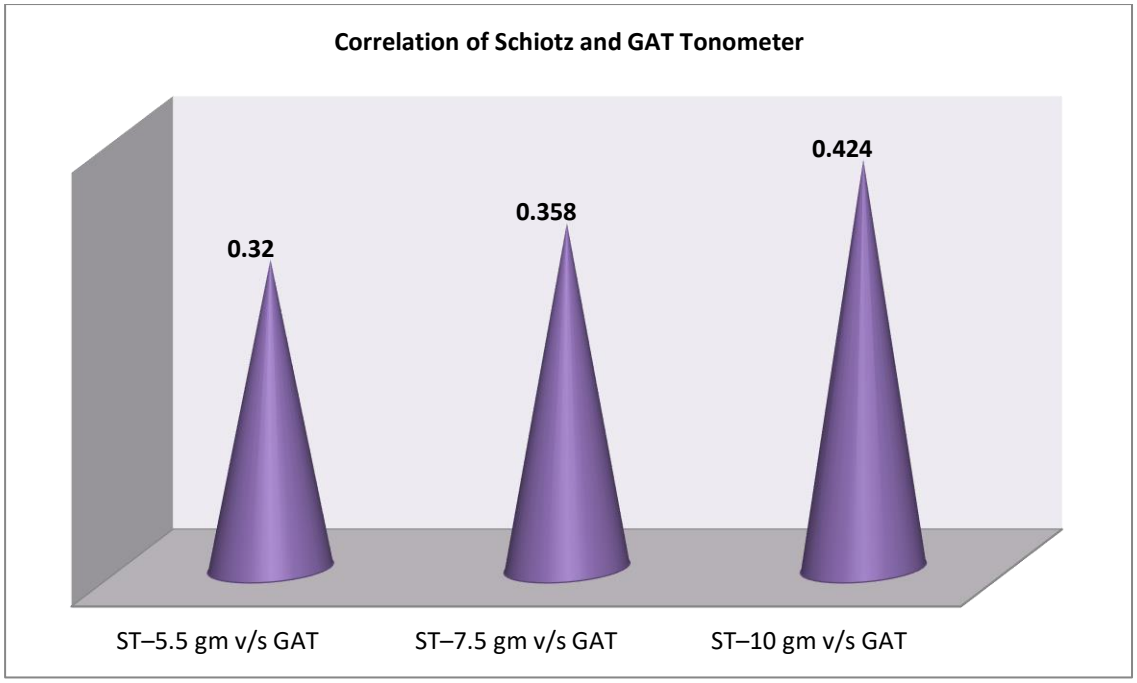

Figure 4: Correlation of Schiotz and GAT Tonometer

Table 3: Comparison of sensitivity and Specificity of Schiotz and GAT tonometer

Tonometer	Specificity	Sensitivity	PPV	NPV
Schiotz	50%	94.2%	80%	88.3%
GAT	53%	96.2%	82.5%	90.6%

GAT showed high specificity and positive predictive value (PPV) as compare to Schiotz tonometer

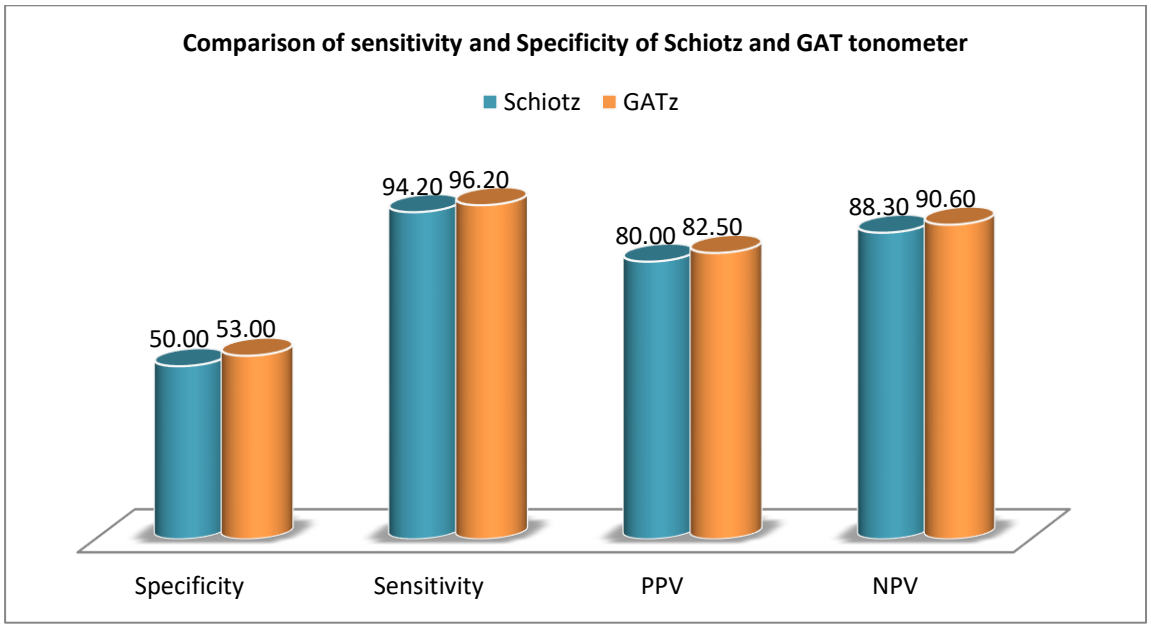

Figure 5: Comparison of sensitivity and Specificity of Schiotz and GAT tonometer

Discussion

In the present comparative study of IOP measurement by GAT v/s ST and as a screening tool in the Haryana population, out of 90 patients, 47 (52.2%) were aged between 40-50 years, 24 (26.7%) were aged between 51-60 years, 13 (14.4%) were aged between 61-70, 4 (4.4%) were aged between 71-80, and 2 (2.2%) were above 80 years (Table 1).

In the correlation study of GAT and Schiotz tonometer, ST–5.5 gm v/s GAT r=0.320 p<0.001, ST–7.5 gm v/s GAT r=0.358 p<0.001, ST-100 gm v/s GAT r=0.424 p<0.001. All the values have sig-

nificant p-values (Table 2). In a comparative study of the specificity and sensitivity of GAT and ST, specificity in ST was 50% and 53% in GAT, and sensitivity was 94.2% in ST, 96.2% in GAT. PPV was 80% in ST, 82.5% in GAT, and NPV was 88.3% in ST, 90.6% in GAT (Table 3) (Figure 1 and 2). These findings are more or less in agreement with previous studies [5,6,7].

Glaucoma is a multifactorial disease with the common endpoint of affecting the optic nerve. It is defined as optic neuropathy characterized by specific structural findings in the optic disc (increased vertical cup-to-disc ratio (VCDR) or VCDR asymmetry >97.5 percentile) and particular functional deficits in automated visual field testing [8].

Normal ocular pressure is essential to maintain the shape of the eye and visual function, with prolonged elevation in IOP resulting in irreversible damage to the retinal ganglion cells and postganglionic nerve fibers [9]. Detecting IOP is not only initiating treatment but also monitoring response to treatment. Despite being the gold standard, there is some intra- and inter-reader variability with the Goldmann applanation tonometer (GAT); Schiotz tonometer can be used in patients who are confined to beds in operating rooms or by general practitioners who provide primary care [10]. Schiotz indentation tonometer (ST) provides only a range of pressures within which the actual IOP lies [11]. ST is about 1.2 mm Hg lower than the mean GAT pressures, indicating that the ST can read lower than GAT. Hence, readings of GAT are more reliable in the detection of positive findings. ST can be used in primary health centers to roughly monitor the IOP in established cases of glaucoma, and patients with a provisional diagnosis of high IOP must be subjected to GAT along with visual field analysis and optic nerve examination at higher centers but since the introduction of the non-contact tonometer, being a direct method would have been superior to ST.

Summary and Conclusion

In the present comparative study of GAT v/s ST, GAT showed good specificity and sensitivity and was reliable in detecting positives excluding false positives. It continues to be theoretically more precise and hence it is considered the gold standard tonometer to diagnose and manage patients with ocular hypertension and glaucoma.

Limitation of study: Owing to remote location of research centre and small number of patients, we have limited findings and results.

This research paper was approved by Ethical committee of Al-Falah School of Medical Sciences and research centre, Dhauj Faridabad, Haryana-121004

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