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Comparison of Intraocular Pressure with iCare Rebound Tonometer and Goldmann Applanation Tonometer

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Abstract: ***The study compares Intraocular Pressure (IOP) measurements obtained using Icare Rebound Tonometer (IRT) and the Goldmann Applanation Tonometer (GAT) while analyzing their correlation with Central Corneal Thickness (CCT). Conducted at a tertiary care center, the cross-sectional study included 156 eyes of patients undergoing routine ophthalmic evaluation. Results indicate that while GAT remains the gold standard for IOP measurement, IRT offers advantages such as ease of use and comfort, particularly for patients with corneal scarring or poor coordination. The findings show that GAT measurements are significantly influenced by CCT, whereas IRT measurements exhibit less dependency. However, IRT tends to overestimate IOP values by approximately 2mmHg compared to GAT, especially in patients with higher IOP values. Consequently, IRT serves as a useful screening tool but should be complemented with GAT for accurate glaucoma diagnosis and management*.**

Keywords: Intraocular Pressure, Goldmann Applanation Tonometer, Icare Rebound Tonometer, Central corneal thickness

1. Introduction

Tonometry is a crucial procedure in regular eye examinations. Accurate measurement of intraocular pressure (IOP) is crucial for managing various eye conditions. Ongoing monitoring of IOP is necessary for nearly all ocular issues, including glaucoma, uveitis, pre- and post-surgical care, ocular trauma, steroid responders, and ocular hypertension. In standard ophthalmic practice, the Goldmann applanation tonometer (GAT) is recognized as the global gold standard for measuring intraocular pressure (IOP). However, it has limitations, including its dependence on central corneal thickness (CCT) and the potential for corneal scarring to produce inaccurate high or low IOP readings. Additionally, corneal astigmatism and the biomechanical properties of the cornea can also affect IOP measurements. With advancements in technology, various types of contact and non-contact tonometers have emerged over the past few decades to address the limitations of the Goldmann applanation tonometer (GAT). One such non-contact device is the Icare PRO® rebound tonometer (IRT) from iCare, Helsinki, Finland, which is now used worldwide. It offers advantages over the GAT, including the fact that it does not require topical anesthetics or fluorescein dye, making it easier to use. Previous studies found that IOP measurement methods including iCare and GAT are affected by CCT. However, corneal thickness is reported to have less impact on the measurements with Icare Rebound Tonometer. The aim of the present study is to compare the Intraocular pressure (IOP) results obtained using the IRT and GAT and correlate the results with the Central Corneal Thickness to assess the reliability of applying RT in clinical procedure.

2. Materials and methods

2.1 Data Acquisition

Patients attending Glaucoma clinic OPD at Tertiary care centre from February 2025- March 2025 were included in the study.

a) Study Design: Cross-sectional study
b) Study Period: February 2025- March 2025
c) Place of Study: Minto Ophthalmic Hospital and Regional Institute of Ophthalmology, BMCRI.
d) Sample Size: Based on previous study by Swathi,[10] et al GAT IOP value among study population was 19.5±8.8mmHg. The sample size calculation is 78 patients (156 eyes)

2.2 Equation

$$n = \frac{Z^2_{\alpha/2}\sigma^2}{d^2}$$

Where,
n= the sample size
$Z_{\sigma/2}$= the standard normal distribution
σ= the standard deviation
d = the desired precision level (expected variation from mean)

$Z_{\alpha/2}$=1.96
σ = 17.3
d = precision = 5% of mean
= 2.71
n = $(1.96)^2$ x $(17.3)^2$ / $(2.71)^2$
n = 156

This is a hospital based cross sectional study of 156 eyes of patients who are undergoing routine evaluation. After obtaining clearance and approval from the Institutional Ethics Committee and written informed consent, patients fulfilling the inclusion and exclusion criteria belonging to tertiary care center were considered for the study. Demographic data (age, gender, occupation) and detailed history was taken. Patients underwent detailed ocular assessment which included visual acuity assessment, slit lamp examination of anterior segment, IOP measurement with Icare rebound tonometer followed by Goldmann applanation tonometer, Central corneal thickness (CCT). Patient were divided into 2 subgroups – Subgroup 1 with <21 mm Hg, Subgroup 2 with > 21 mm Hg. The data was entered in the proforma and analyzed according to appropriate statistical method.

3. Results and Discussions

Examination was carried out by a single examiner. Every patient was evaluated with the Icare Rebound tonometer first to avoid the ocular massaging effect during the examination which could lessen the IOP if GAT was used. Prior to each test, the GAT operator was unaware of the IRT measurements. In less than ten minutes, two tonometer measurements were recorded. The right eye was checked during the examination before the left. Examination was carried out during the office hours.

3.1 Figures

- 78 patients (156 eyes) with healthy cornea were analyzed in our study.
- 50% of the patients were females and 50% males.

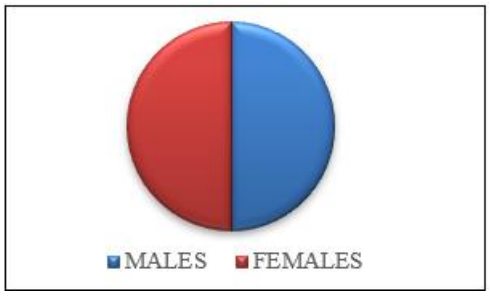

Figure 1: Division of study population

- Age group > 20 years to 80 years were considered.
- Mean age ± SD of subject was 45.3±13.7
- The GAT IOP ranged from 8 to 40mmHg with a mean IOP of 17.5±8.8mmHg
- The Icare IOP ranged from 10 to 42mmHg with a mean of 19.5±9.3mmHg

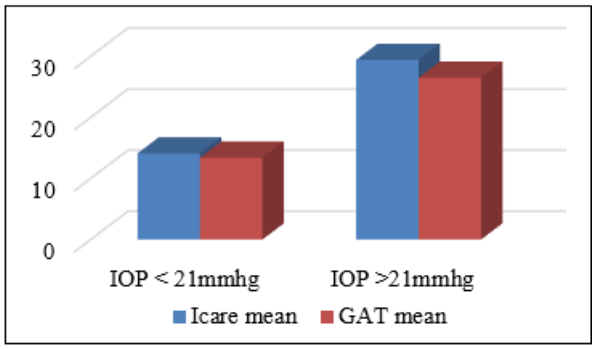

Figure 2: Comparison of iCare and Goldmann Applanation Tonometer in people with IOP <21mmHg and > 21 mmHg

3.2 Tables

Table 1: IOP Correlation with Central Corneal Thickness

		IOP GAT	iCare IOP
CCT	r- value	.224**	.145
	p-value	.005	.071
	N	156	156

- **. Correlation is significant at the 0.01 level (2-tailed).
- The correlation analysis between CCT with GAT IOP shows highly significant positive correlation with r value = 0.224 and p value = 0.005<0.01

3.3 Discussion

One essential step in a standard ophthalmologic examination is tonometry. In particular, IOP is the only modifiable risk factor for diagnosis and management of glaucoma. GAT is acknowledged as the global reference standard for tonometry in clinical applications. The GAT's comparatively high accuracy has made it the standard for evaluating the dependability of different tonometers in clinical settings.

The rebound tonometer probe weighs 24mg and the radius which contacts the cornea is about 0.9mm. Probe touches the cornea at a rate of 0.25-0.35m/sec which is faster than the blink reflex. All these features enable the measurements made by rebound tonometers to be quick and comfortable. When compared with Goldmann Applanation tonometer, features of rebound tonometer can be best used in patients who are disabled, have poor coordination and those with corneal scarring. In this study IOP measurements obtained using 2 tonometers were correlated with CCT and showed that GAT IOP measurement had significant correlation with change in CCT values.

Inferring GAT is more accurate in measuring IOP compared to iCare in clinical practice.

4. Conclusion

Although GAT is the gold standard, improved level of comfort and simple mechanism of use of Icare tonometers have led to widespread use of these devices. Consistent with several prior studies, iCre tonometers overestimate GAT IOPs by approximately 2mm Hg.

For patients with a low to moderate IOP range, Icare Rebound Tonometer is a safe and well tolerated substitute for GAT. However, there is a poor correlation between GAT and the measurements made by IRT in patients with high IOP levels. Hence, Icare tonometers should be used as a screening tool and adjunct to GAT in the diagnosis, monitoring and management of glaucoma.

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