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ORIGINAL ARTICLE

Diagnostic Accuracy of Air Puff Versus Goldmann Applanation Tonometer (Gold Standard) in Measuring Intraocular Pressure Abnormality in Primary Open Angle Glaucoma

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ABSTRACT

Background: Glaucoma is a major cause of blindness worldwide. Intraocular pressure (IOP) disrupts axoplasmic transport in the optic nerve fibers due to compression, leading to the death of retinal ganglion cells. The Goldmann applanation tonometer (GAT) is widely regarded as the gold standard for measuring IOP. The air-puff tonometer also operates on the principle of applanation but uses a puff of air to flatten the central cornea and estimate IOP.

Objective: To assess the diagnostic accuracy of the of air puff vs Goldmann applanation tonometer (gold standard) in measuring intraocular pressure abnormality in primary open angle glaucoma.

Methodology: This cross-sectional comparative study was carried out at Teaching Hospital, Mekran Medical College, Turbat Kech from 1st March 2023 to 31st August 2023 and 200 patients were included. The patients were divided into two groups and each group had 100 patients. Group 1 had patients whose intraocular pressure (IOP) was assessed using the c while in group 2 IOP was measured using the air puff tonometer. In cases of Goldmann applanation tonometer topical anesthesia was achieved using 0.5% drops, and fluorescein dye was applied using a strip placed in the conjunctival sac. The examiner observed the semicircular mires to determine the force required for applanation, which was used to estimate IOP. In contrast, the air puff tonometer uses a short burst of air to briefly flatten the cornea. The device calculates IOP based on the corneal deformation response to this air pulse.

Results: There were majority of the females than males with a mean age of 53.11±11.95 years. The group 1 and group 2 belonged to age groups 18-72 and 19-75 years respectively. The Mean ± SD intraocular pressure in group 1 of the Goldmann applanation tonometer was 13.84±2.29 mmHg while the IOP of the group 2 air puff tonometer was 17.43±2. 30mmHg using Goldmann tonometry, 8% (2 patients) had intraocular pressure (IOP) readings between 7–10 mmHg, 28% (n=7) between 11–14 mmHg. In comparison, air puff tonometry showed that 4% (n=4) had IOP readings of 7–10 mmHg, and 52% (n=52) between 15–18 mmHg in comparison with 35% (n=35%) in Group 1 (GAT having 15-18 mmHg IOP).

Conclusion: The comparison within air puff vs Goldmann applanation tonometer (gold standard) in measuring intraocular pressure abnormality in primary open angle glaucoma presented high diagnostic accuracy of Air puff tonometry with significant efficient and elevated intraocular pressure.

Keywords: Accuracy, Air puff, Goldmann applanation tonometer, Intraocular pressure abnormality, Primary open angle glaucoma

INTRODUCTION

Glaucoma is one of the leading preventable yet irreversible causes of blindness worldwide.[1-3] It is a chronic, multifactorial optic neuropathy characterized by progressive damage to the retinal nerve fiber layer (RNFL) and the optic disc, ultimately resulting in permanent and complete visual field (VF) loss.[2-4] Approximately 3.5% of the global population aged 40 to 80 years is estimated to be affected by some form of glaucoma.[5] Projections indicated that around 76 million individuals were affected by glaucoma in 2020, with this number expected to rise to 111.8 million by 2040.[6]

Several risk factors are associated with glaucoma, including increasing age, race, family history, myopia, diabetes mellitus, hypertension, and smoking.[7,8] Glaucoma is broadly classified into two main types: angle-closure and open-angle glaucoma[9-11], with primary open-angle glaucoma (POAG) being the most prevalent form globally.[12]

Intraocular pressure, the fluid pressure within the eye - typically ranges from 10 to 21 mmHg, with an average value around 16 mmHg. Two primary theories explain the pathogenesis of glaucoma: the mechanical theory and the ischemic theory, both of which emphasize the significance of IOP. According to the mechanical theory, elevated IOP disrupts axoplasmic transport in the optic nerve fibers due to compression, leading to the death of retinal ganglion cells. In contrast, the ischemic theory points that increased IOP compresses the ocular vasculature, reducing blood supply to the optic nerve and ultimately causing blindness.[13]

Among these, the Goldmann applanation tonometer (GAT) is widely regarded as the gold standard for measuring IOP. It uses a dual prism and is mounted on a slit-lamp biomicroscope.[14] The underlying principle of GAT is based on the Imbert-Fick law, which states that the pressure inside a sphere is equal to the force required to flatten its surface divided by the area flattened.[7]

The air-puff tonometer also operates on the principle of applanation but uses a puff of air to flatten the central cornea and estimate IOP. Unlike GAT, the air-puff method is non-contact and non-invasive, minimizing the risk of infection.[12] The present study aims to evaluate and compare intraocular pressure readings obtained using air-puff tonometry and Goldmann applanation tonometry.

MATERIALS AND METHODS

This cross-sectional comparative study was carried out at Teaching Hospital, Makran Medical College, Mekran Medical College, Turbat Kech from 1st March 2023 to 31st August 2023. A total 200 patients were included in the study after they consented for their participation through written informed consent. The sample size, was calculated by we based calculation formula using 95% CI, 80% power of test and 5% margin of error. The participants were clinically examined and confirmed for abnormality in primary open angle glaucoma. All patients who were >18 years were included in the study while those having corneal diseases history or surgeries, ocular trauma, active ocular infections, or other significant eye conditions were excluded. The patients were

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divided into two groups. Each group had 100 patients. Group 1 had patients whose intraocular pressure (IOP) was assessed using Goldmann applanation tonometer while in group 2, IOP was measured using the air puff tonometer. In cases of Goldmann applanation tonometer topical anesthesia was achieved using 0.5% drops, and fluorescein dye was applied using a strip placed in the conjunctival sac. The procedure followed the Imbert-Fick principle, which points that the internal pressure of the eye corresponds to the force needed to flatten a specific area of the cornea. The patient's head was stabilized, the slit lamp was aligned, and the tonometer tip was positioned centrally on the cornea. The examiner observed the semicircular mires to determine the force required for applanation, which was used to estimate IOP. In contrast, the air puff tonometer uses a short burst of air to briefly flatten the cornea. The device calculates IOP based on the corneal deformation response to this air pulse. The non-contact nature of this technique reduces the risk of infection. Data were analyzed using SPSS version 26.0, wherein independent sample t-test was applied for comparative analysis. A p-value less than 0.05 considered statistically significant.

RESULTS

There were majority of the females than males with a mean age of 53.11±11.95 years. The group 1 and group 2 belonged to age groups 18-72 and 19-75 years respectively. There was no significant variance within the groups in terms of gender distribution of age (Table 1).

The mean±SD intraocular pressure in group 1 of the Goldmann applanation tonometer was 13.84±2.29 mmHg while the IOP of the group 2 air puff tonometer was 17.43±2.30mmHg. There was no significant difference in the minimum and maximum pressure of the both methods. However, there was noticeable variance within the mean values of their pressure (Fig. 1).

While the correlation of air puff tonometer was done with the Goldmann applanation tonometer in terms of IOP, it was observe that the correlation factor was 0.715 presenting Air Puff Tonometer suitable for the mass screening purpose (Table 2).

Using Goldmann tonometry, 8% (n=8) had intraocular pressure (IOP) readings between 7–10 mmHg, 28% (n=28) between 11–14 mmHg. In comparison, air puff tonometry showed that 4% (n=4) had IOP readings of 7–10 mmHg, and 52% (n=52) between 15–18 mmHg in comparison with 35% (n=35) in Group 1 (GAT having 15-18 mmHg IOP). Overall, the IOP distribution patterns were similar between the two methods, though air puff tonometry recorded fewer participants in the lowest IOP range (7–10 mmHg) and slightly more in the 15–18 mmHg range while Goldmann tonometry showed a slightly higher proportion overall IOP ranges (Fig. 2).

Table 1: Comparison of the gender and age distribution within group 1 and group 2 patients

Variable	Group 1	Group 2	P value
Gender			
Females	56 (56%)	52 (52%)	0.953
Males	44 (44%)	48 (48%)	
Age (years)	35.40±11.8	35.42±12.1	0.895

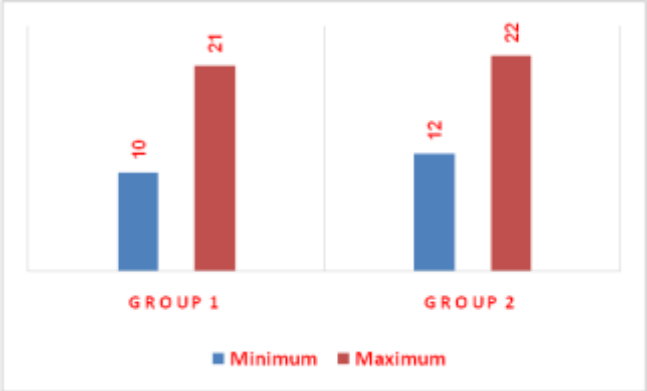

Fig. 1: Comparison of IOP within groups

Table 2: Comparison of Air puff tonometer and Goldmann applanation tonometer correlation factor

Tonometry Method	Mean IOP (mmHg)	Standard Deviation (mmHg)	Correlation with GAT	Key Findings
Air puff tonometer	17.43	2.30	r = 0.715	Higher readings >GAT; suitable for mass screening
Goldmann applanation tonometer	13.84	2.29	—	Gold standard for IOP most consistent and reliable

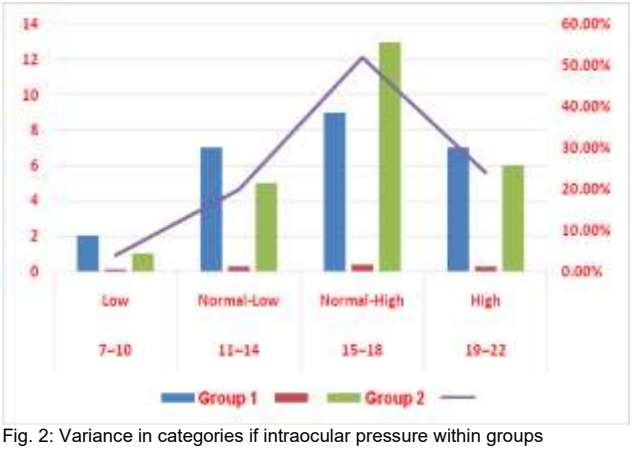

Fig. 2: Variance in categories if intraocular pressure within groups

DISCUSSION

There has been an extensive research on evaluating the intraocular pressure within the patients suffering from glaucoma or non-glaucomatous individuals. It was observed that majority of the research supported the Goldmann applanation tonometer is highly effective while they were other researchers who has also indicated the importance and effectiveness of air puff tonometer with a significant IOP elevated pressure showing that it can be safely and effectively used in patients suffering from abnormality and primary open angle glaucoma.[15,16]

In related research, scientist found a strong correlation between IOP values in healthy adults when measured using different tonometric methods, indicating that the air puff tonometer (APT) could potentially be a reliable tool for glaucoma detection.[17] The data also demonstrated that both measurements of topometric methods were positively influenced by central corneal thickness (CCT).[18]

Both Goldmann applanation tonometer and air puff tonometer are widely used in routine ophthalmologic practice. Goldmann applanation tonometer continues to be regarded as the most reliable and accurate method for IOP measurement and is often referred to as the gold standard.[19] Nevertheless, findings from our study suggest that the air puff tonometer provides nearly equivalent results when compared with gold standard. While Goldmann applanation tonometeris highly accurate, it does come with two notable drawbacks: it requires direct contact with the cornea, which can increase the risk of infection, and it necessitates the use of topical anesthesia, which may be uncomfortable or unsuitable for some patients, particularly children.

Furthermore, the current study supports previous findings indicating that non-contact tonometers can yield clinically

comparable IOP measurements to Goldmann applanation tonometer in individuals with IOP within the normal physiological range.[20]

CONCLUSION

The comparison within air puff vs Goldmann applanation tonometer (gold standard) in measuring intraocular pressure abnormality in primary open angle glaucoma presented high diagnostic accuracy of Air puff tonometry with significant efficient and elevated intraocular pressure.

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