ORIGINAL ARTICLE

COMPARISON OF INTRAOCULAR PRESSURE MEASURED WITH GOLDMANN APPLANATION TONOMETER AND NON-CONTACT AIR-PUFF TONOMETER

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ABSTRACT

Background: Intraocular pressure measurement (IOP) is of pivotal importance for the diagnosis and management of glaucoma. The objective of this study was to compare intraocular pressure measurement with Goldmann Applanation tonometer (GAT) and non-contact Air-Puff tonometer (APT).

Material & Methods: This comparative cross-sectional study was conducted at outpatient Department of Ophthalmology, District Headquarters Teaching Hospital, Bannu, Pakistan, from October 2015 to February 2016. The IOP was measured first with APT (Canon Full Auto Tonometer TX-F, Japan) followed by its measurement with GAT (HAAG-STRIET AT 900, Koeniz Switzerland)

Results: This study included 200 eyes of 100 patients. Among 100 patients, 57(57%) were males and 43(43%) were females. Age range was from 16 to 78 years with a mean of 42.5 years. The IOP measured with APT ranged from 10 mmHg to 47mmHg with a mean of 18.17$\pm$8.25 mmHg, while IOP recorded with GAT ranged from 10 mmHg to 41mmHg with a mean of 15.59$\pm$7.75 mmHg. There was a significant difference in the mean IOP measured with APT and GAT, with APT recording a mean IOP of 2.58 mmHg higher than GAT ($p=0.003$).

Conclusion: Both APT and GAT are commonly used for IOP measurement. There is a reasonably good agreement between the two tonometers at IOP within the normal range. However GAT is more accurate and reliable. APT overestimates IOP, particularly in cases above the upper limit of normal IOP. The results of APT should be confirmed with GAT, particularly when the IOP exceeds the normal range for the diagnosis and treatment of glaucoma.

KEY WORDS: Ocular Tonometry; Intraocular pressure; Glaucoma.

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INTRODUCTION

Tonometry is the objective measurement of intraocular pressure. Intraocular pressure (IOP) is one of the most important parameters and plays a role of paramount importance in the diagnosis, progression and management of glaucoma. Glaucoma is a specific optic neuropathy characterized by specific visual field loss, optic disc damage and usually but not invariably elevated IOP. Glaucomatous damage can occur at IOP lower than the upper level of normal IOP of 21 mmHg (normal IOP ranges from 10-21 mmHg) as in case of normal tension glaucoma. On the other hand, the IOP may be higher than 30 mmHg but still there is no glaucomatous damage as occurs in case of ocular hypertension. Glaucoma causes irreversible loss of vision. It is the second leading cause of blindness in the world and considered to affect 79.6 million people by 2020.[1] IOP is the only modifiable factor in glaucoma.[2,3] Proper control of IOP bears profound impact on the progression and treatment of glaucoma.[4,5] In glaucoma, the target is to reduce IOP by approximately one-third or more

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depending upon the severity of the disease. Lowering IOP by 30% or more slows the rate of visual field (VF) loss.[6] Greater IOP fluctuation increases visual field loss by 30% and IOP progression is the only factor associated with VF progression[7]. Treatment reduces the risk of glaucoma by 50%.[2] Reduction of 1mmHg will reduce the progression of glaucoma by 10%.[8,9]

There are various types of tonometers like Goldmann Applanation tonometer (GAT), Air Puff tonometer (APT), Perkin's tonometer, and Transpalpebral tonometer. Goldmann Applanation tonometer (GAT) is a slit lamp mounted tonometer based on the Imbert-Fick principal which states that the pressure inside a sphere equals the force necessary to flatten its surface divided by the area of flattening. GAT is the gold standard"[10,11] and the most reliable of all the tonometers. To fathom the reliability of any tonometer, comparison of its results with those of GAT is important. If its results are comparable and in good agreement with GAT, then it can be branded reliable.

Air Puff tonometer (APT) does not need contact with the eye or the use of local anesthesia. Instead it uses a jet of air and the time needed to flatten the cornea relates directly to the level of IOP. It is easy to use and can be used even by non-ophthalmologists for glaucoma screening.

Objective of this study was to compare the IOP measurements with GAT and APT and to gauge the reliability of APT in IOP measurement.

MATERIAL AND METHODS

This comparative cross-sectional study was conducted at outpatient department of Ophthalmology, District Headquarters Teaching Hospital, Bannu, from October 2015 to February 2016. It included hundred patients visiting eye OPD. Any condition that could either influence the results of IOP measurement or render IOP measurement difficult such as patients' non-cooperation, ocular conditions like keratoconus, pterygium, high degree of astigmatism, active conjunctival and corneal diseases and corneal opacities were excluded from this study. Patients were examined including visual acuity, pupillary reactions and slit lamp bimicroscopy and ophthalmoscopic examination of both anterior and posterior segments.

After explaining the procedure to the patients, the IOP was first measured with Air Puff tonometer (Canon Full Auto Tonometer TX-F, Japan). Three readings were taken in each patient and an average of the three reading was calculated.

The patients then underwent IOP measurement with Goldmann Applanation tonometer (HAAG-STREIT AT 900, koeniz switzerland) after instilling local anesthetic in each patient's eyes and application of fluorescein strips to eyes, about half an hour following IOP measurement with Air Puff tonometer (APT) in order to prevent IOP lowering which may occur following IOP measurement with APT.

Independent t-test was performed for comparision of the mean IOP recorded with the two tonometers. SPSS version 16.0 was used for statiscical analysis.

RESULTS

This study included 200 eyes of 100 patients. Among 100 patients, 57 (57%) were males and 43 (43%) were females. Range of age was from 16 to 78 years with a mean of 42.5 years. The IOP measured with APT ranged from 10 mmHg to 47 mmHg with a mean of 18.17 ± 8.25, while IOP recorded with GAT ranged from 10 mmHg TO 41mmHg with a mean of 15.59 ± 7.75 as is evident from Table 1 & 2.

The number of eyes with IOP ranging from 10-20mmHg were 147 (73.5%) with APT while those

Table 1: Intraocular pressure measured with Air-puff Tonometer (Canon Full Auto Tonometer TX-F, Japan).

Total Eyes	IOP Range	Mean	Standard Deviation
200 Eyes	10 - 47 mmHg	18.17 mmHg	8.25 mmHg

Table 2: Intraocular pressure measured with Goldmann Applanation Tonometer (HAAG-STRIET AT 900, Koeniz Switzerland).

Total Eyes	IOP Range	Mean	Standard Deviation
200 Eyes	10 – 41 mmHg	15.59 mmHg	7.75 mmHg

Table 3: Number of Eyes with different Intraocular Pressure Ranges measured with Air-puff Tonometer and Goldmann Applanation Tonometer.

IOP Range	10-20 mmHg	21-30 mmHg	31-40 mmHg	41-47 mmHg	Total Eyes
APT	147 (73.5%)	36 (18%)	13 (6.5%)	4 (2%)	200
GAT	173 (86.5%)	19 (9.5%)	6 (3%)	2 (1%)	200

recorded with GAT were 173 (86.5%) in the same range. In the same manner the number of eyes with IOP from 21-30mmHg measured with APT were 36 (18%) and 19 (9.5%) with GAT. Furthermore the number of eyes with IOP recorded from 31-40mmHg were 13 (6.5%) with APT and 6 (3%) with GAT. Lastly eyes having IOP measured from 41-47mmHg were 4 (2%) with APT and 2 (1%) with GAT as demonstrated in table 3.

There was a significant difference in the mean IOP measured with APT and GAT, with APT recording a mean IOP of 2.58 mmHg higher than GAT ($p=0.003$).

DISCUSSION

The IOP measurement is one of the essential parameters for the diagnosis and management of glaucoma. Both Goldmann Applanation Tonometer (GAT) and Air Puff Tonometer (APT) are widely used for IOP measurement. GAT is the most accurate and reliable of all the tonometers and the accuracy and reliability of any tonometer is judged on the basis of its results comparable with GAT.

This study demonstrated good agreement between GAT and APT regarding IOP measurement within the normal range, i.e. 10-20 mmHg. However at IOP higher than the normal range, APT consistently overestimated IOP as compared to GAT. Studies regarding comparison of IOP measurement with APT and GAT show different results but most of them reveal overestimation of IOP by APT compared with GAT.

A study conducted by Ahmad et al[12] found that APT consistently overestimated IOP as compared with GAT and the overall accuracy was of APT was 49.70%, which was mostly accurate (54.40%) in the normal range of IOP of 10-20 mmHg. Similarly Rao et al[13] reported that the difference in IOP measured with GAT and APT was not significant in the normal range of IOP but revealed significant difference in IOP measurement between GAT and APT at IOP exceeding the normal range. Salim et al[14] observed close and good agreement between GAT and APT within the normal range of IOP but at higher level of IOP, the two tonometers revealed greater variations. Nadeem et al[15] found good agreement between GAT and APT in individuals with IOP in the normal range. Al-Mubrad[16] found good agreement between non-contact Air Puff tonometer and Goldmann Applanation tonometer with no significant difference regarding IOP measurement by the two tonometers. Similarly Shah et al[17] observed that GAT is more reliable and the measurement of IOP by the two tonometers differed significantly. Farhood et al[18] demonstrated that ATP overestimated IOP in as much 74% of cases compared with GAT. Similarly, Ogbuechi et al[19] found that Pulsair Easy Eye noncontact tonometer (APT) though accurate and reliable in normotensive population, consistently measured IOP higher than GAT.

CONCLUSION

Both APT and GAT are widely used for IOP measurement and glaucoma screening and show good agreement at IOP within the normal range. However, GAT is more accurate and reliable. APT overestimates IOP, particularly at level higher than the normal range. Therefore the results of APT should be confirmed with GAT, particularly when the IOP exceeds the normal range for appropriate IOP measurement and appropriate diagnosis and treatment of glaucoma.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

Conception and Design:	HM
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