ORIGINAL ARTICLE

Comparison of Intraocular Pressure Measurement by Goldmann Applanation Tonometry and Pneumotonometry in Healthy Subjects and Patients with Primary Open Angle Glaucoma

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ABSTRACT:

Objective: To evaluate the role of non-contact Pneumo-tonometry (PT) by comparing intraocular pressure (IOP) measurements with Goldmann Applanation Tonometry (GAT) and PT in healthy subjects, and patients with Primary Open Angle Glaucoma (POAG).

Materials and Methods: This prospective comparative study was conducted at PNS Shifa Naval Hospital, Karachi from January 2016 to June 2016. A total of 360 eyes of 180 patients were included, and IOP measurement was done using GAT and PT methods. The difference in readings between the two methods was calculated and analysed using SPSS version 17.

Results: A total of 360 eyes were analysed. 90 healthy subjects (180 eyes) and 90 patients with diagnosed POAG (180 eyes) were included. Mean IOP measured in all eyes using GAT and PT was 16.32±5.31 mm of Hg and 18.16±6.76 mm of Hg respectively. Mean difference in IOP was 2.31±1.89 mmHg between two methods, with 278(77.22%) eyes showing higher IOP reading than those measured using GAT. The difference of readings between two methods was statistically significant. The patients with POAG were divided into three groups. Group 1 had IOP less than 15 mm Hg, Group 2 had IOP between 15-25 mm Hg and Group 3 had IOP greater than 25 mm Hg. Mean difference in IOP between two methods was 1.38±1.85, 2.29±2.72 and 3.05±2.68 mm Hg in Group 1,2 and 3 respectively. The mean difference of IOP measurement using GAT and PT in these groups was statistically significant (P<0.001)

Conclusion: IOP measurement using PT overestimates the recorded IOP as compared to GAT, and the difference is more pronounced in eyes with higher than normal IOP.

Keywords: Tonometry, Glaucoma, Primary open angle, Intraocular pressure

INTRODUCTION:

Aqueous humor is secreted by the ciliary process in the posterior chamber and leaves the anterior chamber through the trabecular meshwork. There is balance between inflow and outflow which maintains normal intraocular pressure (IOP) inside the eyeball.[1,2] Correctly measuring IOP is very important in diagnosing glaucoma and conducting follow-ups.[3]

Glaucoma is the second-leading cause of blindness in Africa[4] and whole world.[5] It is an irreversible optic neuropathy that has potential sight threatening consequences. The disease significantly affects the vision related quality of life. All the epidemiological surveys have concluded that the disease is highly under diagnosed, and most of the patients remain un-diagnosed till later stages, where damage has been done already.[6] Since glaucoma has multivariate etiology, wherein intraocular pressure (IOP) is the most important and only modifiable risk factor, lowering the IOP is a major available treatment modality to physicians.[7] The accurate IOP measurement has a very important role in diagnosis as well as management of glaucoma. Different methods of IOP measurement or tonometery are Goldman Applanation tonometry (GAT), Noncontact Pneumo tonometry (PT), Perkins tonometry, Tonopentonometry, and Transpalpebral tonometry.[8] However, GAT is still the gold standard for the measurement of IOP.[9,10] GAT despite being the gold standard IOP measurement has its limitations; Influence by corneal edema, astigmatism, fluorescein staining, wide pulse pressure, variation

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Received: 10-08-2016
Revised: 25-09-2016
Accepted: 28-09-2016

by breath holding, increased pressure on globe or stiff collar and incorrect calibrations are few of factors responsible for incorrect IOP measurement by GAT.[11] Air puff or PT is a non-invasive method to measure IOP without need for anesthesia and risk for corneal abrasions and infections.[12] The purpose of this study is to compare the measurement of IOP from GAT and PT, and to evaluate the difference in the IOP measurement from the two devices in normal healthy subjects, as well as patients with primary open angle glaucoma (POAG).

MATERIALS AND METHODS:

After approval by the hospital ethical review committee, informed written consent was taken from the patients prior to inclusion in the study. Patients aged between 20-40 years, with best corrected visual acuity (BCVA) of 6/6 on Snellen's visual acuity chart, central corneal thickness (CCT) from 500µm to 550µm and astigmatism of less than 2D were included. The IOP of POAG was further divided into three groups. Group 1 with IOP <15, group 2 with IOP 15-25 and group 3 with IOP >25. Those with history of corneal surgery or diseases, keratoconus, inability to maintain fixation during PT, poor cooperation during PT and GAT IOP measurement, sensitivity to fluorescein and corneal edema were excluded. Those fulfilling inclusion criteria underwent complete ophthalmic examination, with visual acuity measurement, automated refraction using Canon RK-F1 Full Auto Ref-Keratometer and measurement of CCT using Topcon SP 3000P Specular Microscope (Topcon Corporation, Tokyo, Japan).All subjects underwent PT before GAT to avoid false reduction in IOP after applanation. PT was done usingTopcon CT-80 model (Topcon Corporation, Tokyo, Japan).Three measurements were taken for each eye, and mean of three readings was recorded.GAT was done after using proparacaine hydrochloride ophthalmic solution, 0.5% eye drops (Alcaine, Alcon Laboratories, Inc, Fort Worth, TX) and a fluorescein strip was applied to the inferior conjunctival fornix for a few seconds. Pressure on globe was avoided and patients were advised to keep breathing normally under relaxed environment during GAT. GAT was done using Haag-StreitÊGATs (Model AT 900 C/M). All IOP measurements were recorded from 10am to 2pm, by single examiner to exclude bias. All data was recorded in proforma for record keeping. Statistical package for social sciences (SPSS 17.0) for windows was used for statistical analysis. Descriptive statistics that is mean ± standard deviation for quantitative values (age, CCT, IOP, Difference in IOP) and frequencies along with percentages for qualitative variables (gender) were used to describe the data. Shapiro Wilk's test was used to check normality of data. Post normality testing , Paired 't' test was used to compare IOP measurement between GAT and PT. One way ANOVA test was used to compare mean difference in IOP measurement using two methods between different sub groups of patients with POAG. P value < 0.05 was considered statistically significant.

RESULTS:

Mean age of all patients was 28±7.35 years. 95 (52.78%) were males and 85 (47.22%) were females. Mean CCT was 526±34µm. Out of 90 healthy subjects, 56 (62.22%) were males and 34 (37.78%) were females, with mean age of 26±6.85 years. Out of 90 patients with POAG, 51 (56.67%) were males and 39 (43.33%) were females, with mean age of 27±5.89 years. Mean IOP measured using GAT and PT, with mean difference of IOP measurements in all patients (360 eyes), and separately for healthy subjects and patients with POAG is given in Table 1.The difference in IOP values between the two devices was statistically significant (P < 0.001). Comparison of IOP values measured by PT as related to those measured by GAT, in frequency is given in Figure 1. Eyes with POAG were further divided in three groups. Group 1 had IOP less than 15mmHg (87 eyes, 48.33%), Group 2 had IOP between 15-25mmHg (69 eyes, 38.33%) and Group 3 had IOP greater than 25mmHg (24 eyes, 13.34%). Mean IOP measurements using two instruments with mean difference in these groups is given in Table 2 and Figure 2. The mean difference of IOP measurement using GAT and PT in these groups was statistically significant (P<0.001).

Table: 1
Results of IOP Measurement

Group	GAT (mmHg)	PT (mmHg)	Mean Change (mmHg)	P Value
All eyes (n=360)	16.32 ± 5.31	18.16± 6.76	2.31± 1.89	< 0.001
Eyes of Healthy Subjects (n=180)	15.06± 4.32	16.98± 5.36	1.97± 3.46	< 0.001
Eyes of POAG patients (n=180)	16.13± 8.25	18.97± 7.39	2.85± 6.12	< 0.001

Table: 2
IOP values measured by GAT, PT and their difference according to IOP groups of patients with POAG

	Group 1 IOP <15mmHg	Group 2 IOP 15-25mmHg	Group 3 IOP >25mmHg
GAT	12.16±3.26	17.45±3.29	29.16±4.72
PT	13.42±4.12	19.76±4.21	33.16±4.57
Difference	1.38±1.85	2.29±2.72	3.05±2.68

Figure: 1
IOP values measured by PT as related to those measured by GAT, in Frequency

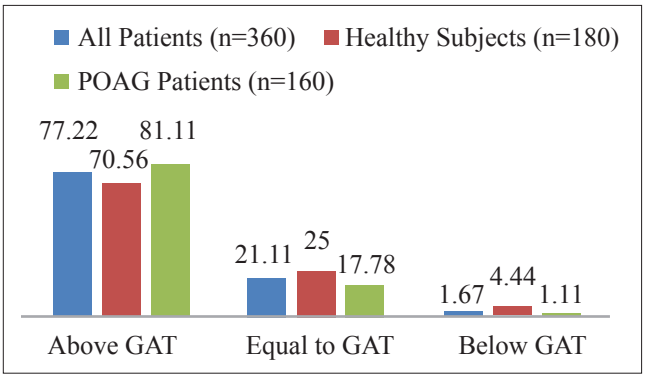
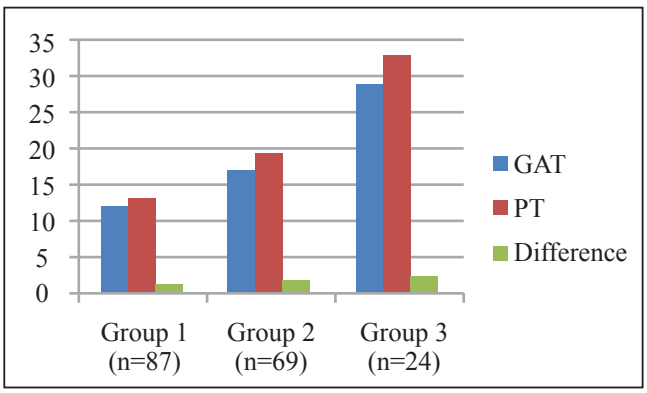


Figure: 2
IOP values measured by GAT, PTand their difference according to IOP groups of patients with POAG



DISCUSSION:

GAT and PT are two main methods being used for measurement of IOP now-a-days. As GAT requires expertise and there is chance of transmission of infection due to contact method, PT is being used extensively for IOP measurement in outpatient departments. Due to increase dependency on PT by eye specialist there is a need to evaluate the accuracy of this method as compared to GAT which is still considered as gold standard for measuring of IOP.

Our study shows there is difference in IOP measured by PT as compared to IOP measured by GAT. PT showed higher value in most of patients. In total 360 eyes of 180 patients the mean IOP measured by GAT was16.32 ± 5.31 as compared to mean IOP measured by PT 18.16± 6.76. PT showed higher mean IOP measurements difference of 2.31± 1.89.

In healthy population 180 eyes of 90 patients, the mean IOP measured by GAT was 15.06± 4.32 as compared to mean IOP measured by PT was16.98± 5.36. PT showed higher mean IOP measurement difference of 1.97± 3.46.

In POAG group population 180 eyes of 90 patients the mean IOP measured by GAT was 16.13± 8.25 as compared to mean IOP measured by PT 18.97± 7.39. PT showed higher mean IOP measurement of 2.85± 6.12. It shows that there is high IOP measurements by PT in both healthy population as well as POAG group which means that IOP measurement by PT can be misleading in IOP measurements for screening. When we analysed the IOP measurements in these three groups, it showed that in higher IOP group that is group 3 the difference in mean IOP measured by PT and GAT was 3.05±2.68 which is more as compared to mean IOP of lower IOP group 1 that was 1.38±1.85. Different studies have been conducted to show the difference in IOP measured by GAT as compared to PT.[13,14,15,16,17] A study done by Firat[13] showed that IOP measurements by PT were higher as compared to IOP by GATs. Martinez-de-la-Casa[14] measured IOP with GAT as compared to non contact tonometers. This study result showed that IOP measured by GAT was lower as compared to IOP measured by non contact tonometers. In another study by Tonnuet [15] mean difference in IOP between GAT measurements and PT measurements was 0.7 mmHg where as our study showed a difference of 2.31± 1.89. In one study done by Lagerlöf [16] IOP measurements by non contact tonometer were more inaccurate between 20 and 30 mmHg and in another study by Rao [17] concluded that IOP measurements by non contact tonometer were more reliable for IOP of less than 20 mmHg. Our study has shown that difference in IOP measured by GAT and PT is more for patients in higher IOP group 3 with IOP > 25.

GAT is still considered as gold standard for measuring IOP butÈrepeated corneal applanation in GAT can result in statistically significant reduction in IOP on subsequent measurements.[18] PT may be useful in screening and clinical settings but borderline-high IOP readings should be confirmed with GAT.[19]

In our study one short coming is that in order to keep parameters simple and manageable some parameters that can influence the IOP measurement by GAT and PT like astigmatism, corneal curvature, biomechanics and axial length were not considered.[20,21,22,23,24] The corneal properties can affect IOP measurement by both GAT and non-contact tonometer but the PT is more affected by central corneal thickness than the GAT.[25] The main advantage of PT is that IOP can be measured easily by any assistant without use of topical anesthetic and with very low risk of transmission of infection and other complication like corneal abrasion as compared to GAT. Only drawback is that PT over estimates the IOP as compared to GAT. It can be a good tool for screening of bulk patients for IOP measurements but all patients with high IOP must be checked with GAT before labeling these patients as having raised IOP.

CONCLUSION:

IOP measurement using PT overestimates the recorded IOP as compared to GAT, and the difference is more pronounced in eyes with higher than normal IOP. GAT is still gold standard for measurement of IOP for diagnosis of glaucoma and monitoring progression of disease. However PT can be used for mass screening of patients to rule out raised IOP in susceptible population reporting to eye out patient departments.

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