 DOI: 10.18231/2395-1451.2017.0081

Comparison of rebound tonometry with applanation tonometry for intraocular pressure measurement

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Abstract

Purpose: To compare the readings of the Goldmann's applanation tonometry with that of the iCare Ta01i in Indian patients.

Materials and Methods: Intraocular pressure measurements were obtained in 440 eyes of 220 subjects in which 320 were normal eyes and 120 eyes had a high IOP. A thorough examination was done and IOP was measured in all subjects using iCare Ta01 tonometer and the Goldmann's applanation tonometer 3 times each and the average was taken. All examinations and measurements were done by the same 2 personnel.

Results: Intraocular pressure measurements with ICare Ta01 tonometer compared with the Goldmann's applanation tonometer were not found to have a significant difference (mean ±2.34mmHg). The 95% confidence interval between readings with the 2 methods was within acceptable limits.

Conclusion: The ICare Ta01 tonometer measurement of intraocular pressure showed excellent correlation with those from the Goldmann applanation tonometer, which is the gold standard for IOP measurement. The iCare, with all its advantages over the GAT, can be used as a routine instrument for measurement of IOP in ophthalmology practice.

Introduction

The intraocular pressure (IOP) is the only modifiable factor in glaucoma and its measurement is very important in the screening, diagnosis, treatment, prognosis and follow-up of glaucoma and for all types of intraocular surgeries. Thus, the precision of the measurement of this factor cannot be overemphasized. Goldmann's applanation tonometry (GAT) is considered the gold standard for the measurement of IOP.[(1)] Quite a few disadvantages have been found with the use of GAT. For example, it may be affected by central corneal thickness (CCT), may carry infections from one eye to another and may cause injury to the corneal surface. Also, it needs a slit lamp for its working.[(2)] Topical anesthesia and fluorescein need to be instilled before its use and this may lead to allergic reactions and reflex blepharospasm.[(3)] The necessity of slit-lamp biomicroscopy makes it difficult to measure IOP in the handicapped, the elderly, bedridden patients and children. Several different methods have been proposed to overcome the disadvantages in GAT.[(1)]

Rebound tonometry is also known as "dynamic tonometry" or "impact tonometry". The concept was first presented by Obbink in the 1950s. Dekking and Coster furthered it in the 60's.[(4)] Major contribution for the same was done by Kontiola in the 1990s.[(5)] The principle works by a probe hitting the an eye which is monitored by motion sensors and, after it touches the cornea, the rate of rebound of the probe gives information about IOP depending on the speed of the return; if it returns slowly, the IOP values are low and if it returns fast, IOP values are high. After good results for IOP measurements shown by Kontiola, a new handheld tonometer based on this principle, the i-Care was made available in 2003 for widespread use.[(6)]

Six readings are taken in quick succession by propelling a sensor tip of about 2 mm diameter against the centre of the cornea from the instrument base which is held at a distance of about 4–8 mm from the anterior surface of the eye. It usually doesn't even trigger the highly sensitive blink reflex. The digital display then shows the average of the six readings taken. It also shows the SD as low, medium or high. It has many advantages over other instruments, the major ones being that it needs no topical anesthesia and that it is handheld.[(6,7)]

The purpose of this study was to compare the readings of the GAT with that of the iCare Ta01i (Tiolat Oy, Helsinki, Finland) in a large group of Indian patients.

Objectives

1. To find, on a large scale, whether IOP by iCare can be compared to the IOP by the gold standard Goldmann's Applanation Tonometry.
2. To find, if any, the differences made by the two methods in patients with a high IOP.

Materials and Methods

The approval of the local medical ethics committee was taken for the study and an informed consent was obtained from each subject. The study was in accordance with the recommendations of the Declaration of Helsinki.

Patients: This prospective observational study included 440 eyes of 220 subjects, having a mean age of 58±12 years (range 18-80 years).

Inclusion criteria: Individuals attending ophthalmology OPD in the tertiary care centre.

Exclusion criteria: Corneal astigmatism of more than 2D, corneal disorders, microphthalmos, history of ocular surgeries in the past 3 months, ocular inflammation, contact lens usage.

Protocol: All subjects were put through a complete ophthalmological examination which included the best-corrected visual acuity (with retinoscopy), a detailed anterior segment examination using a slit lamp, and fundus examination using a direct ophthalmoscope and a 90- diopter lens.

All instruments were calibrated and measurements were performed as per the instructions and guidelines given by the manufacturer. All readings were taken by the same two doctors, one for GAT and one for iCare tonometry. iCare tonometry was done first and then GAT as GAT requires instillation of topical anesthesia.

The iCare tonometer is a light-weight handheld device, having of a probe and a solenoid. The technology is on the basis of the rebound measuring principle. The probe is made up of a 50mm long stainless steel tube with a plastic ball at the end of size 1.8mm. A magnet is fixed in the steel tube. For measuring the IOP, the device is held near the patient's eye, the base supported by the patient's forehead, and the edge of the ball is kept around 5-8 mm from the eye. When the button for measuring the IOP is clicked, an electrical pulse goes to the solenoid which forms a magnetic field. This makes a spring push away the magnet and thus the ball. The ball is plunged towards the eye. It hits the eye and bounces back. This movement of the probe and of the magnet attached to it causes an electric impulse in the solenoid depending on the velocity of the probe. Movement parameters of the probe are recorded during this. This current is turned into a digital IOP reading by a processor using sophisticated methods of analysis. The software is programmed to take six readings.[12] Thus, 6 readings were taken in a similar manner. The biggest and the least of the readings are excluded by the instrument and the average of the remaining readings is calculated. No anesthesia is needed for this procedure. If the final average IOP had any error sign showed by a line beside the reading, that value was discarded and the whole process was repeated.

For GAT, topical proparacaine anesthesia was instilled. A fluorescein strip was applied to the eye. IOP was measured thrice with the GAT (Haag Streit, Koeniz, Switzerland) and the average IOP value was determined.

Results

The sample size was calculated by the estimation method with correlation coefficient = 0.95 for the relative error of 10% using hypothesis testing for single correlation coefficient with power 80% and level of significance 5%. Purposive sampling was done.

The IOP values from the 2 tonometry methods was assessed using the Bland-Altman method (23), which included the calculation of the mean difference between measurements, standard deviation (SD) and the 95% confidence interval (CI). Statistical analysis was done using the SPSS statistical software (ver. 11.0; SPSS Inc., Chicago, IL).

440 eyes of 220 subjects were taken into the study. Of these, 320 eyes were normal whereas 120 had a high IOP. The study had 109 female and 111 male patients (mean age: 58±12 years; range: 18–80 years). These included 320 normal eyes, 66 eyes (33 patients) with ocular hypertension and 54 eyes (27 patients) with glaucoma. None were on treatment yet.

Descriptive Statistics: For normal subjects

Method	IOP (M±SD)	t-value
iCare	12.84±3.37	-34.338
GAT	12.86±3.41	-33.366

$p<0.05$

For subjects with high IOP

Method	IOP (M±SD)	t-value
iCare	24.33±2.34	
GAT	24.13±2.33	

$p<0.05$

In most cases, IOP measurements using Icare Ta01i were equivalent to those obtained by GAT. The Bland–Altman plot comparing them showed reasonable agreement.

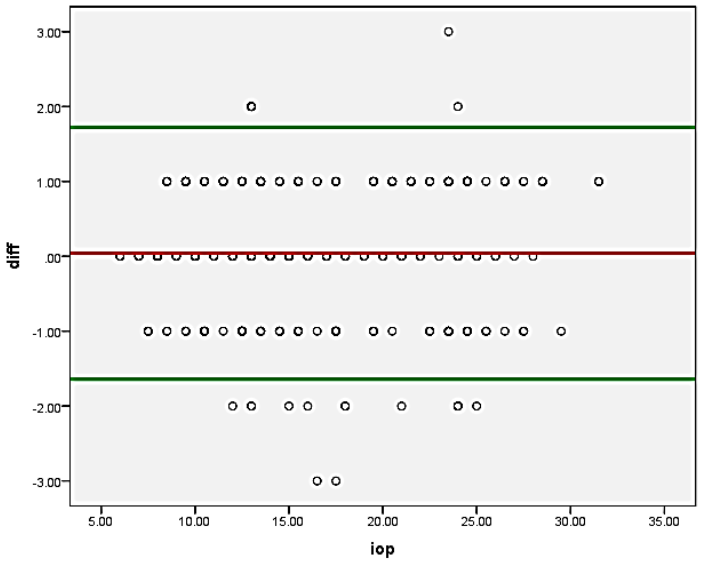

Fig. 1: Bland-Altmann Analysis

Regression analysis

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	2.368	1	2.368	3.232	.073[b]
	Residual	320.896	438	.733		
	Total	323.264	439			

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-.156	.117	.086	-1.335	.183
	IOP	.012	.007		1.798	.073

The intraocular pressure compared between iCare and Goldmann Applanation Tonometer has a good correlation with $p<0.05$.

Discussion

A study conducted by Pakrou N, Gray T, Mills R, Landers J, Craig J. on 292 eyes showed that there is good correlation between the 2 methods of IOP measurement with a mean difference of 0.6mm Hg, even at extremes of IOP.[8] The same was reflected in our study where the 2 methods were comparable with a mean difference of 0.2mm Hg. The iCare instrument was easy to use and recorded rapid and consistent readings with minimal training. It seems to be more comfortable than GAT and obviates the need for topical anaesthesia.[8]

In our study, the 2 methods were in good correlation with each other which was in agreement with another cross-sectional study from the Royal College of Ophthalmologists in which the agreement between GAT and iCare was seen to be clinically acceptable.[9] GAT was significantly affected by CCT; iCare was influenced to a lesser extent by CCT and corneal curvature. The iCare appeared less influenced by corneal edema when compared with GAT.[9]

In yet another study from the American Journal of Ophthalmology, Nandini et al had studied the effects of IOP measurements by iCare and GAT on glaucomatous patients and concluded that the 2 are comparable with each other.[10] The same was seen even in our study where even in glaucomatous patients the 2 methods had comparable results.

A recent study among normal individuals in the United States indicated the intraocular pressure measurements obtained with the new ICare ONE tonometer show excellent correlation with those provided by the Goldmann applanation tonometer, the gold standard of tonometry.[11] Measurements using the new ICare ONE in normal, healthy subjects produced a small, statistically insignificant bias when compared with the Goldmann applanation tonometer differences.[11]

Conclusion

The ICare Ta01 tonometer measurement of intraocular pressure showed excellent correlation with those from the Goldmann's applanation tonometer, the gold standard for IOP measurement. There was a statistically insignificant difference in the intraocular pressure between GAT and iCare Ta01 in both normal subjects and subjects with a high IOP. The iCare, with all its advantages over the GAT, can be used as a routine instrument for measurement of IOP in ophthalmology practice.

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