Original Article

Comparative evaluation of applanation and indentation tonometers in a community ophthalmology setting in Southern India

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Abstract

Purpose: Measurement of intraocular pressure (IOP) is one of the basic investigations in a general ophthalmic workup. In this study, we attempt to determine the agreement in the measurement of IOP obtained by Perkin's applanation tonometer, noncontact tonometer and Schiotz indentation tonometer in patients attending general ophthalmology OPD in a tertiary care centre in South India and its use in a community ophthalmology setting.

Methods: A cross-sectional analytical study in which IOP was measured in patients using the three tonometers. Central corneal thickness (CCT) was measured using Ultrasonic pachymetry. Bland Altman analysis was done to evaluate the agreement between instruments.

Results: 800 eyes of 400 patients were included in the study. By Bland Altman method, Schiotz indentation tonometer was found to have better correlation to IOP obtained by Perkin's applanation tonometer. Schiotz indentation tonometer was found to be most accurate when CCT was in the range of 501–550 μm and noncontact tonometer was found to be least accurate when CCT was greater than 600 microns. On comparing correlation at different age groups, both the methods had better correlation at <40 years age group.

Conclusion: Both the tonometers showed a significant correlation with the gold standard technique (Perkin's applanation tonometer) over a range of IOP and CCT with the Schiotz tonometer better than the NCT. This study proves that Schiotz tonometer can be recommended as a reliable screening tool in community outreach ophthalmology services. The twin advantages of portability and availability make the Schiotz tonometer a popular choice among ophthalmology trainees and optometrists in a developing country like India.

Keywords: Perkin's tonometer, Noncontact tonometer (NCT), Schiotz indentation tonometer, Intraocular pressure (IOP), Tonometry, Central corneal thickness (CCT)

Introduction

Worldwide, Glaucoma is the second most common cause of irreversible visual loss, with its prevalence in South India varying between 1.62% and 2.6%.[1,2]

A chronic optic neuropathy with characteristic structural and functional changes in the optic nerve head, an important risk factor for glaucoma is increased Intraocular pressure (IOP). A normal intraocular pressure is essential to maintain the shape of the eye and visual function with prolonged

elevation in IOP resulting in irreversible damage to the retinal ganglion cells and postganglionic nerve fibres.[3] Detecting the IOP is essential in not only initiating treatment, but also in monitoring the response to treatment.[4] The past few decades have seen a rapid evolution of tonometry instrumentation to ensure more accurate measurement of IOP. However, both ocular and nonocular factors often exert confounding influences in the accurate measurement of the IOP and complicate the treatment.[5]

Public sector health institutions in India primarily serve the underprivileged sections of the society and rural camps are the most effective measures to screen the population for debilitating vision disorders. In population screenings and rural camp settings for glaucoma detection, the ease of operability and cost significantly influence the selection of the tonometer. Also, in many instances, absence of sufficient manpower requires the services of an optometrist to perform a quick IOP measurement. However, the accuracy of such cheap and user-friendly tonometer may be called into question in comparison with the gold standard. It, therefore, becomes essential to determine the reliability of these tonometers and also to determine their usefulness in special situations.

In this study we aimed to evaluate the efficacy of Schiotz indentation tonometer and Non-contact tonometer (NCT) in measuring the IOP as compared to Perkins handheld applanation tonometer (handheld model of Goldman applanation tonometer (GAT- the gold standard)) and to determine the inter-instrument agreement of these tonometers with Perkins tonometer over a range of central corneal thickness (CCT). The reliability of these tonometers with Perkins tonometer during mass screening of IOP in rural and community outreach eye camps was also analysed.

Materials and method

This study was approved by the Institute Research Board and Ethical Committee. Over a 4 month period (January–April 2013), patients of both sexes between the ages of 20–80 years attending the outpatient services were randomly screened and included in this study. Patients with pre-existing corneal pathologies and nystagmus were excluded from the study. The IOP was measured by a single investigator using the Noncontact Tonometer, Perkin's applanation tonometer and Schiotz indentation tonometer in that order to prevent lowering of IOP induced by contact. In all cases, a 5 min interval was ensured between any two methods of IOP measurement and an average of three measurements was taken as the final IOP obtained by that method. CCT was measured with the Altair Ultrasonic pachymeter after tonometric measurements had been completed.

First, the patient was seated at the tabletop model of Canon TX-10 Noncontact Tonometer (Canon USA Inc, USA) and asked to fix at the target. The examiner aligned the cornea by superimposing the reflection of the target from the patient's cornea on a stationary ring. An air puff was automatically triggered when alignment was satisfactory.

Then, the patient's cornea was anaesthetized with topical application of 0.5% proparacaine hydrochloride and the tear film stained with sodium fluorescein using paper strips impregnated with fluorescein. With the patient in a sitting position, under cobalt blue light illumination, the biprism of Perkin's tonometer (Haag-Streit, USA) was brought into gentle contact with the centre of the cornea. The fluorescein semicircles were viewed through the biprism, and the calibrated dial was adjusted till the inner edges overlapped. The reading on the dial was multiplied by ten for the IOP value.

Finally, the patient was placed in a supine position and asked to fix at a target. Zero error of Schiotz indentation tonometer (Medetz Surgical, USA) was taken by placing the footplate on the test block provided. The eyelids were separated by hand without exerting pressure on the globe, and the tonometer foot plate was placed on the anaesthetized cornea so that the plunger moved freely vertically. The scale reading was noted. The 5.5 gram weight was initially used, but if scale reading was four or less additional weights were added to the plunger. The subsequent readings were taken with additional weights to overcome the influence of sclera rigidity. These readings were converted to IOP measurement in mm of Hg by using Friedenwald's table.

Following the completion of IOP measurements, the ultrasonic pachymetry probe (Optikon 2000 S.p.A, Altair, Rome, Italy) was placed on the centre of the anaesthetized cornea. Three consecutive readings were taken and averaged to get the central corneal thickness. CCT values were categorized as per the findings of the Los Angeles Latino Eye Study Group.[6]

The results of all four diagnostic investigations were analysed by Microsoft Excel Program for frequency distribution and computed in percentages.

Statistical analyses were performed using MedCalc for Windows, version 13.3.1 (MedCalc Software, Ostend, Belgium). IOP measurements were compared to those obtained by the Perkin's handheld applanation tonometer which was assumed to be the gold standard (Sensitivity, specificity, positive and negative predictive values). Regression Analysis was also performed to determine any causal relationship (Dependant variable -Perkin's Tonometer IOP; Independent variables- Noncontact tonometer IOP, Schiotz tonometer IOP, age, gender and CCT). A Bland–Altman plot was constructed to investigate the existence of any systematic difference between the different tonometry methods.

Results

Both the eyes of all included patients have been studied. Therefore for our analysis, background characteristics were calculated based on sample size of 400 patients while the remaining analysis was based on 800 eyes.

The study population comprised of 36 per cent males with mean age of 54 years (95% CI 52.8–55.5, range 26–78 years) and 64 per cent females with mean age of 55.6 years (95% CI 54.7–56.7, range 20–80 years). The mean age of all patients in this study was 55.1 years (95% CI 54.3–55.9 years).

The mean CCT was 527.5 microns (μm) (95% CI 524.6–530.5) ranging between 360 μm and 646 μm. Maximum eyes (n = 423) had CCT in the range of 501–550 μm and only 48 eyes had CCT above 600 μm.

The mean of IOP measured by Perkin's Tonometer, Noncontact Tonometer and Schiotz Tonometer was 13.8 mmHg (95% CI 13.5–14.2), 13.9 mmHg (95% CI 13.5–14.2) and 14.97 mmHg (95% CI 14.7–15.3) respectively. Most eyes (n = 497) had values between 11 and 20 mmHg while only