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To Evaluate Comparitive Values Ofapplanation, Indentation& Non-Contact Tonometry on Different Refractiveerror Groups

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Abstract:
AIM*: To compare and contrast the objective measurement of IOP using the Schiotz indentation tonometer, Applanation tonometer and the non-contact air puff tonometer in patients with various refractive errors.***MATERIAL& METHODS***: A comparative study conducted on a discrete population of 150 patients all of whom attended the outpatient department of our Hospital,Maha Rani LaxmiBai Medical College, Jhansi, INDIA on a voluntary basis;150 patients were selected at random for this study ,came in opd of this medical college for period of 6 month from April 2018 toSeptember 2018.Examination of each patient included slit lamp biomicroscpe and direct ophthalmoscopic examination. Tonometric readings were taken by Goldmann's applanationtonometer, Schiotz tonometer &non-contact tonometer. **REULTS:** In our study 150 patients were taken & divided into 3groups on the basis of different refractive error ,one is myopic <6D ,second is myopic >6D and third is hypermetropic. In first group schiotz read highervalue more than Perkin's&non-contact tonometer, in second group Perkin's reads higher value than schiotz &air puff tonometer and in third group schiotz reads higher than Perkin's & air puff tonometer.* **CONCLUSION;** *we conclude that; in patients with high myopia (> 6 Diopters) a Perkins Applanation tonometer reads higher than Schiotz and Air puff tonometer. In patients with Hypermetropia, Schiotz tonometer reads higher than Applanation and Air puff tonometer.*
KEYWORDS: *Perkin's tonometer, Noncontact tonometer (NCT), Schiotz indentation tonometer, Intraocular pressure (IOP)*

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I. Introduction

Worldwide, Glaucoma is the second most common causeof 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 normalintraocular pressure is essential to maintain the shape of the eye and visual function with prolongedelevation in IOP resulting in irreversible damage to the retinal ganglion cells and postganglionic nerve fiber[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 non-ocular 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.Tonometry is the most important parameter in diagnostic, therapeutic and prognostic evaluation of Glaucoma. Recording of intraocular pressure in human attained a scientific momentum with the discovery of Schiotz indentation tonometer, non-contact tonometer and Goldmann's appalantion tonometer. Goldmann's applanation tonometer has received a great importance because this method is independent of ocular-rigidity, it is little influenced by variations in corneal curvature and it records the intraocular pressure directly by applanatingthe cornea.In Goldmann's applanation tonometry surface tension of tear film and the force required to bend the cornea cancel each other. Thus making Imbert - Fick - law applicable to this method.Goldmann's applanation tonometer shows no topographic effect and there by gives reproducible measurements on repeated measurements. Schiotz tonometry is affected by ocular-rigidity, instrumental errors, reading errors of its scale, thickness and curvature of cornea, contraction

of extra-ocular muscles and accommodation. Schiotz tonometry also has tonographic effect there by fails to give consistent readings; instead it shows progressively low intra ocular pressure measurement than previous one on repeated indentation on cornea. Indentation tonometer underestimates the intra-ocular pressure in conditions of low-ocular rigidity while it overestimates it in conditions of high ocular rigidity. Under-estimations of intra-ocular pressure gives falls sense of security which is dangerous because of fear of missing glaucoma. Some workers had pointed out that some of the cases of so called low-tension glaucoma may be the result of such under-estimation.Though goldmann's applanation tonometer is accurate method for measurement of intra ocular pressure it also carries the risk of infection and corneal aberrations same as schiotz indentation tonometer.Intra ocular pressure can be affected by various factors like, age,race,sex,genetic,ethnicity,diurnal variation,associated systemic diseases like hyper tension,neural control,hormonal effects,effect of general anesthesia and increased episcleral venous pressure.So by controlling or excluding associated risk factors intra ocular pressure measurements can be compared from various aspects.As these methods are different in their principle as well as different working instrument it is quite difficult to compare them but based on the careful work up on patients and instrumental parameters we can fairly compare these methods for accuracy, reliability, reproducibility as well as for various advantages and disadvantages of given methods.

II. Material &Methods

A prospective comparativestudy was conducted over a period of six months from April 2018 to September 2018 at Maha Rani Laxmi Bai medical college& hospital Jhansi, India. Sample was taken from the patients visiting the hospital in outpatient department on voluntary basis. Written informed consent was obtained from the patients to participate in the study. The institutional review board of the hospital approved the study and all methods adhered to the tenets of the Declaration of Helsinki for research involving humans. 150 patients were selected at random for this study.

These patients were selected with reference to the following guide lines:

- No specific attempts was made to separate the population on basis of gender.
- Thepatients selected covered all age groups from 7 to76 years.
- Patients belowthe age of 7 yrs. were not included in the study as the anticipated difficulties of performing applanation tonometry and Schiotz tonometry in this sub group were evident.

Exclusion criteria:

- History of corneal disease including but not limited to: Majordystrophies, Keratoconus, Connective Tissue disorders, Stevens Johnson Syndrome,severe dry eyes, Corneal edema and scars
- Use of eye drops or contact lens
- History of inflammatory eye disease
- One eyed subjects
- History of major ocular trauma
- History of major ocular infection
- Uncontrolled diabetes mellitus
- Any abnormality preventing reliable IOP readings(High corneal astigmatism, uncooperative subjects etc.)
- History of hypersensitivity to topical fluorescein
- Pregnant or breast feeding women

Examination of each patient included routine anterior segment examination with slitlamp biomicroscpe and direct ophthalmoscopic examination. Tonometric readings were taken by Goldmann's applanation tonometer,Topconnon-contact tonometer &Schiotz tonometer. Findings were recorded as per the followingproforma.To avoid any discrepancy due to diurnal variations and scleral rigidity due to too long and too short axial length, the time of tonometry was kept between 09:30 hours to 11:00 hours and patients with axial length between 22-25 millimeters were taken in to consideration. Goldmann's tonometer on mounted on slit lamp biomicroscope, Topcon air puff non-contact tonometer and weighted Schiotz with 1955 calibration tables were used.The same instruments were used throughout the study.Three readings were taken with each instrument and average value is determined with an interval of five minutes between each instrument and one minute between each reading. IOP measured first by Topconnon-contact tonometer then applanation tonometer and lastly with Schiotz tonometer with 5.5 gmwt. The IOP noted were recorded with a view to analyze the same.First, the patient was seated at the tabletop model of Topcon Non-contact Tonometer (Topcon, Japan) 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 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 Goldman's tonometer 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 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.

III. Results

1 .Distribution of Cases

Table (1) Gender and refractive status of the studied population. The table (1) shows the total population of 150 patients divided into the following sub groups.

TABLE. 1

GROUPS	MALES	FEMALES	TOTAL
MYOPIA	50	18	68(45.3%)
HYPERMETROPIA	33	16	49(32.6%)
PAOG	22	11	33(22%)
TOTAL	105	45	150(100%)

Table (2) Relations of IOP measurement by various Tonometric methods in sub group of myopic patients include myopia of less than 6 Diopters. All values are in mm of Hg.

TABLE: 2

Tonometric Methods	MEAN IOP (+/-SD)		
	Right Eye	Left Eye	Average
Air Puff	12.14+/-1.26	12.08+/-1.28	12.12+/-1.20
Applanation	13.34+/-2.42	13.56+/-2.30	13.45+/-2.43
Schiotz	13.40+/-1.63	13.61+/-1.61	13.49+/-0.05

Comparison of Tonometer	'P' value	significance
Air Puff v/s Applanation	P < 0.05	SIGNIFICANT
Air Puff v/s Schiotz	P < 0.05	SIGNIFICANT
Applanation v/s Schiotz	P > 0.05	NOT SIGNIFICANT

From table.2, it is evident that difference between average IOP in Schiotz and Applanation tonometer is 0.045 i.e. insignificant in clinical practice. Average IOP by Schiotz and air puff tonometer shows a difference of 1.375 where in Air puff shows numerically lower measurement of IOP than does Schiotz tonometer and this difference is SIGNIFICANT. Average IOP by Applanation and air puff tonometer shows a difference of 1 .33 where in Air Puff tonometer shows numerically lower measurement of IOP as is the case with Schiotz tonometer and this difference too isSIGNIFICANT.

Table (3): Relations of IOP measurement by various Tonometric methods in sub group of myopic patients include myopia of more than 6 Diopters.

TABLE: 3

Tonometric Methods	Mean I.O.P. (+/-S.D)		
	Right Eye	Left Eye	Average
Air Puff	12.32+/-1.05	12.14+/-1.13	12.20+/-1.15
Applanation	15.10+/-1.21	15.60+/-2.19	15.40+/-2.18
Schiotz	14.10+/-2.51	14.52+/-2.37	14.34+/-2.40

Comparison of Tonometer	'P' value	significance
Air Puff v/s Applanation	P < 0.05	SIGNIFICANT
Air Puff v/s Schiotz	P < 0.05	SIGNIFICANT
Applanation v/s Schiotz	P > 0.05	NOT SIGNIFICANT

From this table it is evident that difference between average IOP in Schiotz and Applanation tonometer is 1.06 where in applanation tonometer shows numerically higher measurement of IOP than does Schiotz tonometer and this is not significant. Average IOP by Schiotz and air puff tonometer shows a difference of 2.14 where in Air puff shows numerically lower measurement of IOP than does Schiotz tonometer and this difference is SIGNIITICANT. Average IOP by Applanation and air puff tonometer shows a difference of 3.20. Again, Air Puff tonometer shows numerically lower measurement of IOP than does Applanation and this difference isSIGNIFICANT.

Table (4): Relation of IOP measurement by various Tonometric methods in Hypermetropic patients. All values in mms. Of Hg.

TABLE:4

Tonometric Methods	**Mean I.O.P. (+/-S.D)**		
	Right Eye	Left Eye	Average
Air Puff	14.36+/-2.33	14.57+/-2.30	14.46+/-2.31
Applanation	14.57+/-3.05	14.00+/-2.92	14.81+/-2.96
Schiotz	15.78+/-2.52	16.20+/-2.44	16.02+/-2.48

Comparison of Tonometer	'P' value	significance
Air Puff v/s Applanation	P > 0.05	NOT SIGNIFICANT
Air Puff v/s Schiotz	P < 0.05	SIGNIFICANT
Applanation v/s Schiotz	P < 0.05	SIGNIFICANT

From this table it is evident that difference between average IOP in Schiotz and Applanation tonometer is 1.21 where in Schiotz tonometer shows numerically higher measurement of IOP than does applanation tonometer and this is SIGNIFICANT. Average IOP by Schiotz and air puff tonometer shows a difference of 1.56 where in Air puff shows numerically lower measurement of IOP than does Schiotz tonometer and this difference is SIGNIFICANT. Average IOP by Applanation and air puff tonometer shows a difference of 0.35. Again, Air Puff tonometer shows numerically lower measurement of IOP than does Applanation and this difference is not significant.

IV. Discussion

When a discrete population of apparently normal eyes was examined by Air puff, Applanation and Schiotz tonometry; the agreement between the values of the airthematic averages obtained in individual eye, significant difference in estimates of IOP of same eye obtained by three methods was shown to be in concordance with a desirable frequency in clinically important range of IOP.

a) Distribution of cases: In the present study of 150 patients, for the sake of convenience cases were divided into three groups, Hypermetropia (49), myopia (68) and patients with POAG (33). They are again divided on the basis of gender. 105 patients were male and 45 cases were females. The subgroups of myopic patients were further divided into high myopia (more than 6 Diopters) and low myopia (less than 6 Diopters). Cases were also divided age wise into three groups ranging from 7 to 76 years, group 1: 7 -20 years, group 2:21 - 45 years and group 3 : 46 - 76 years. Glaucoma cases were also divided according to refractive state of two eyes. In 33 cases with POAG, 21 were with myopia and 12 were with Hypermetropia.

b) Relation of Myopia to Various Parameters and Tonometric Methods

In the present study; the mean Applanation I.O.P. was nearly the same as the mean Schiotz 5.5 gm. Difference being 0.05 which is not significant (P > 0.05) in the low myopic patients while in the high myopic patients the mean Applanation I.O.P. was higher than the mean Schiotz 5.5 gm.wt. Value difference being 1.06 which is also not significant (P > 0.05).This was in accordance with the studies of Isabelle McGarry and Eveanstion (1960) who found thatApplanationtonometry showed higher I.O.P.s in eyes having a low scleral rigidity. Similarly, Smith et al (1967), Sorsby et al (1957), Schmidt et aland Abdulla and Hamid (1970) and Temlinson & Phillips (1970) reported higher IOP readings with Applanation as compared to Schiotz tonometer in myopic patients[13, 14, 20]. Smith et al (1964) and Jackson et al (1965) showed the difference between Applanation and Schiotz readings to fall within the range of 1.3 mms. of Hg. Similarly, Schwarta (1966) also reported; discrepancy of 1.21 mms. Of Hg between Applanation and Schiotz measurements[11, 34, 35].Jain and Chaudhary (1974) reported statistically significant difference between Schiotz and Applanation tonometry in high and moderate myopia. And Cordova (1970) states that in high myopic patients the Applanation tonometer would be the

tonometer of choice. The slight difference in the results of our studies could be due to the discrete population, which we are studying; having different parameters as compared to the population studied by the other investigators [12].We found that the mean IOP by Air puff tonometer in the subgroup of population "low myopia" were lower than both Schiotz and Applanation tonometer wherein the difference with both is almost the same (1.37& 1.35 respectively). The mean IOP difference b/w Air puff tonometer and Applanation is higher (3.20) than Air puff and Schiotz (2.14) in the high myopic patients.The studies conducted by Derka et al (1980), Yucel AA, Sturmer J. Glorr B (1990), Lagerlof (1990), Brencher, Kohl, Reinke and Yolton (1991) proved that Pulse air read low readings across the entire range of IOP. Studies by Draeger, Jessen and Haselmann (1975) and Buscemi, Capoferri, Garavagllia, Nassivera and Nucci (1991) have shown that the Air puff tonometer is a valuable choice for screening purposes [11, 13, 14, 20, 27]. Our, studies correlate with the above studies and the difference although being significant gives us a fair idea of the intraocular pressure of the patient. The lower readings with Schiotz tonometer probably were due to the low scleral rigidity in this subgroup but we are unable to explain the low readings with Air puff tonometer in comparison with Applanation tonometer.

c) Relation of Hypermetropia to Various Parameters and Tonometric Methods:

In this study, we found that mean Schiotz IOP was higher 1.21 than Applanation IOP. The studies conducted by Sorsby et al (1957), Schmidt et al (1956) and Temlinson Phillips (1970) have reported lower tensions by Applanation tonometer as compared Schiotz tonometer in hypermetropes [32,33].Studies conducted by Jackson (1965) and Schwarta (1966) have reported differences of 1.3 and 1.21 mms. Of Hg

Respectively between Applanation and Schiotz tonometry. In our studies, we got a difference 1.21 mms. of Hg between the two tonometers. Jain and Chaudhary (1974) reported non-significant difference between Schiotz and Applanation tonometer in hypermetropes[9,10,11,13,14,20] but in our studies we have got a significant difference ($p < 0.05$). This could be due tothe study of discrete population having slightly different parameters as compared to population in the study.We also found that mean IOP in Air puff tonometer in this sub group of population were lower than both Schiotz and Applanation IOP. Wherein difference between Air puff IOP and Schiotz is 1.55 is more than with Applanation 0.35. Studies conducted by Shields (1980), Brencher, Kohl, Reinke and Yolton (1991) and Buscemi, Capoferri, Garagagllia, Nassivera and Nucci (1991) have reported Air puff tonometer to measure low readings across the entire range of IOP and the Air puff tonometer is less reliable than the conventional Applanation and Schiotz tonometer[13,14,19,20] . This is in accordance to the findings of our study

V. Conclusion

In this study, we have compared objective measurement of IOP with Schiotz indentation tonometer, Perkins Applanation tonometer and a Topcon non- contact tonometer of 150 patients who attended outpatient department of our hospital. In our study, we conclude that: In patients with high myopia (> 6 Diopters) a Perkins Applanation tonometer reads higher than Schiotz and Air puff tonometer. In patients with Hypermetropia, Schiotz tonometer reads higher than Applanation and Air puff tonometer In subgroup population of high myopia we are unable to explain the observed IOP difference between Air puff and Applanation tonometry (3.505). Since this study is doneon small population, need for further evaluation on large population probably would enable us to explain the same.

References

[1]. Stevens GA, White RA, Flaxman SR, Price H, Jonas JB, Keeffe J, et al. Vision Loss Expert Group. Global prevalence of vision impairment and blindness: magnitude and temporal trends, 1990–2010. Ophthalmology 2013; 120:2377–84.

[2]. Vijaya L, George R, Paul PG, Baskaran M, Arvind H, Raju P, et al. Prevalence of open-angle glaucoma in a rural south Indian population. Invest Ophthalmol Vis Sci 2005; 46:4461–7.

[3]. Quyang PB, Li CY, Zhu XH, Duan XC. Assessment of intraocular pressure measured by Reichert ocular response analyzer, Goldmann applanation tonometry, and dynamic contour tonometry in healthy individuals. Int J Ophthalmol 2012;5:102–7.

[4]. Medeiros FA, Alencar LM, Sample PA, Zangwill LM, Susanna Jr R, Weinreb RN. The relationship between intraocular pressure reduction and rates of progressive visual field loss in eyes with optic disc hemorrhage. Ophthalmology 2010; 117:2061–6.

[5]. Chui WS, Lam A, Chen D, Chiu R. The influence of corneal properties on rebound tonometry. Ophthalmology 2008; 115:80–4.

[6]. Becker-Shaffer's Diagnosis and Therapy of the Glaucomas,By Robert L. Stamper, Marc F. Lieberman, Michael V. Drake

[7]. Comparative evaluation of applanation and indentation tonometers in a community ophthalmology setting in Southern India.

[8]. 8. SwathiNagarajan,a, VeerabahuVelayutham,b and G. Ezhumalaic, Saudi J Ophthalmol. 2016 Apr-Jun; 30(2): 83–87

[9]. 9.ABRAHAMSON, I. A. Sr., ABRAHAMSON, I. A. Jr. (1959): Scleral rigidity and tonometry in the aged. Am. J.O. 48: 389, 1959.

[10]. 10.CASTREN, J.A., PHJOLA S.(1961): ActaOpth.3g: 1011- 1015, 1961. Quoted by Buke Elder in Systems of Ophthalmology. Vol. IV.

[11]. SMITH, J. L. (1964) : Incidence of Schiotz - applanation disparity. Am. J. O. 58 : 807, 1964.

[12]. SCHWART, J. T. (1968) : Comparison of Goldmann and Schiotz tonometry in community. Arch. Ophth. 75:788, 19614.

[13]. HOSNI, P. (1965) : Clinical evaluation of applanation and Schiotz tonometry. Anr. J. O. 60:967, 1965.

[14]. SEEGER, F. L. et al (1965): Clinical evaluation of applanation and Schiotz tonometry. Am. .I. O. 60: 95, 1965.8.

[15]. GUPTA, S.P., MEHTA, P.(1963):Indian J. O. 16:74, 1963.

[16]. DUKE, ELDER (1968): System of ophthalmology. Vol. IV, 227 -245: 263 -27 5, I 968. The intraocular pressure.
WEINSTOCK, F. J., and KAPETANSKY, F. M. (1963): Comparison of 1948 and 1955 Schiotz tables with applanation tonometry. Am. J. O. 55: 868, 1963

[17]. BAYARD, W. L. (1970): Comparison of Goldmann applanation and Schiotz tonometry using 1948 and 1955 conversion table. Am. J. O. 69 1007, 1970.
[18]. CORBOY, J. M., KENNE'IH, A. (1971): Mechanical sterilization of applanation. Arn J.O.7l :891, 1971.
[19]. JACKSON, C.R.S. (1965) : Schiotz tonometers an assessrnent of their usefulness. Br. J . O. 49: 478, 196526.
[20]. JAIN, I. S. , CHAUDHARY, J.(1974): Ind. J. O. 22:15,1974.
[21]. SORENSEN (1975): The non-contact tonometer. Clinical evaluation on normal and diseased eyes. ActaOphthalmocopenh-Lg7s Sep: 53(a); 513-21.
[22]. BECKER, SHAEFFER (1973): Diagnosis and therapy of the glaucomas. 55 - 66, 440-443, 1973 .
[23]. SHIELDS (1980) :Thc non-contact tonometer. Its value andlimitations. Surv- Ophtalmo 1980 Jan-Feb; 24 (4): 211-9.
[24]. DERKA (1980) : The American optical non-contact tonometer and Goldmann applanation tonometer. Klin-monatsblAugenheilkd 1980 Nov; 177(5) : 634-42.
[25]. ABDULA, M. I., HAMDI, M. (1981) : Perkins hand held applanation tonometer. Br. J. Ophth. 32: 568, 1981
[26]. DRAEGER, JESSEN AND HASELMANN (1975): Principle and results of a new "non-contact-tonometer". Klinmonatsbl-Augenheilkd 1975 Jul; 167(l):27-34.
[27]. LAGERLOF - O (1990) : Air-puff tonometry versus applanation tonometry. Actaophthalmolcopenh. 1990 Apr; 68(2):221-4.
[28]. BRENCHER, KOHL AND OTHERS (1991) : Clinical comparison of air puff and Goldmann tonometer. J-Am-OptomAssoc. I 991 May 62(5): 395-402.
[29]. BUSCENI, CAPOFERRI AND OTHERS (1991) : Non contact tonometry in children optom-vis-sii. L99l Jun; 68(6):461-4.
[30]. MYERS AND SCOTT (1975): The non-contact ("air puff') tonometer. Variability and corneal staining Am-JOptamphysiol-opt. 1975 Jan; 52(1) :36-46.
[31]. SUGAR: Quoted by Duke Elder in system of ophthalmology. Vol. VII.
[32]. Robert Ritch, M. Bruce Shields, Theodore Krupin - The Glaucomas.
[33]. ROSEN, D. A., WARMAN, A. G. (1964) : observation on the clinical determination of scleral rigidity. Am. J. O. 57:111, 1964.
ARMALY, M. P., SALOMON, S. G. (1965) : Schiotz and Applanation tonometry. Arch. Opth. 75:ll, 1965.

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