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Research article

ASSESSMENT OF THE FACTORS INFLUENCING AND COMPARING THE INTRAOCULAR PRESSURE WITH THE HELP OF SCHIOTZ INDENTATION TONOMETER AND GOLDMANN'S APPLANATION TONOMETER: A CLINICAL STUDY

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ABSTRACT

Background: Intraocular pressure (IOP) is the fluid pressure inside the eye and is maintained by the equilibrium between the forces determining the formation of aqueous humour and the alteration in the resistance to its outflow. IOP is important to evaluate patients who are at an increased risk of glaucoma. Clinically measurement of IOP is based on principles of indentation and applanation and such a method is called Tonometry. The tonometers used today are the Schiotz Indentataion Tonometer (ST) and the Goldmann's Applanation Tonometer (GAT). However the latter is accepted as the standard one. **Aim**: 1) To estimate the normal mean IOP for the population under study.2) To study the various factors- age, sex, refractive errors that influence the IOP.3) Merits and demerits of the individual tonometers. **Method:** A sample size of 100 cases of 200 sets of eyes was taken and divided into 2 groups, Group A with emmetropia, myopia, hypermetropia of both sexes and Group B with frank glaucomatous changes of both sexes. 3 consecutive measurements with GAT were recorded in each eye followed by ST with 5.5gm weight first followed by ST with 7.5gm weight. The whole database was recorded and statistically analysed. **Results:** Out of the total 200 eyes studied, Group A consisted of 168 apparently normal eyes which included emmetropes, myopes and hypermetropes and Group B comprised of 32 eyes which were frank glaucomatous cases with glaucomatous field defects. On estimating the mean IOP with the help of GAT and ST between the 2 eyes there was not a significant difference. On comparing the refractive status, myopes showed a higher IOP than hypermetropes and emmetropes. With both GAT and ST females had higher IOP than males. The mean IOP increased as age progressed. Group B studies which had frank glaucoma cases showed that the IOP measured with GAT was higher and more accurate to the actual IOP value whereas the readings with Schiotz were variable and unreliable. **Conclusion:** IOP is one of the key metrics which is used to monitor the health of one's eye especially an eye with glaucoma. The IOP measured with GAT was more accurate towards the true intraocular pressure and hence Applanation Tonometer is considered gold standard in measuring IOP.

Keywords: Intraocular pressure, Goldmann's applanation tonometer, Schiotz indentation tonometer

INTRODUCTION

The intraocular pressure of the eye is determined by the balance between the amount of the aqueous humor that is manufactured by the eye and the ease with which it leaves the eye. Early in the 17th century, an English physician Richard Bannsiter noticed that in spite of performing cataract surgeries there was no improvement in the vision[1]. Later in the 19th century, William Bowman developed a method to estimate the

tension of the eye by palpating the closed eyelid with his fingers. Eventually they came to a conclusion the higher the IOP, the greater is the chance that the eye would become blind. Later instruments were being developed for more objective measurement of IOP and it was believed that IOP above 21 mmHg is abnormal and the goal of glaucoma treatment was to lower the IOP below 21 mm Hg.[2]

There are various factors that can influence the IOP. Some of the short term factors are-ocular pulse, straining, breath holding, posture, accommodation, eye rubbing, contact lens removal. While the medium term factors include diurnal variation, eating and drinking, smoking, systemic medication, exercise, Optometric techniques and the long term factors include age, general health of the individual, gender, season and ocular factors.

The main symptom of increase in intraocular pressure is the gradual loss of vision. Hence it is very important to have a regular eye check up for glaucoma later in life as in some cases the progression is gradual and the patient may not even realise it. Sudden onset of throbbing pain and redness in the eye, headache, blurring of vision, halos around light, dilated pupil, nausea and vomiting are some of the common and critical symptoms of raised intra ocular pressure. In cases of young children watering from the eyes, sensitivity to light and eye lid spasm is common.

According to the current census ophthalmologists define the normal intraocular pressure as that pressure, which is within 10 to 20 mm Hg[3] with the average value being 15.5 mm Hg with fluctuations of 2.75 mm Hg.[4] Ocular hypertension is defined when the intra ocular pressure is higher than normal, in the absence of optic nerve damage or visual field loss. Hypotony can be defined as IOP less than or equal to 5 mm Hg. This could probably be due to fluid leakage and deflation of the eye ball.[5]

Glaucoma is group of ocular disorders that results in optic nerve damage or a loss to the field of vision which is caused by an increase in the intraocular pressure. [6] It can be classified into open or closed angle glaucoma wherein the angle refers to the space between the iris and the cornea through which the aqueous fluid escapes via the trabecular mesh-work.

Glaucoma tends to be inherited and may not show up until later in life[7] and usually gets worse with time. If the damage to the optic nerve due to the increased intraocular pressure continues, then it can lead to a tunnel vision and finally a permanent loss of vision.

Tonometry is a non invasive technique of measurement of IOP. It measures the pressure without cannulating the eye. However manometry in reference to the eye is undoubtedly the only accurate technique, but it is not applicable clinically. Hence a more indirect approach was taken up using a tonometry wherein the tension of the outer coats of the eye is assessed by measuring its impressibility or applanability[8]

METHODS AND MATERIALS

Patients were selected from the OPD of Dept of Ophthalmology, Meenakshi Medical College, Kanchipuram. Written consent was taken from the subjects and was explained to them in their own language. Prior to the study the ethical clearance was obtained from the Institutional Ethics Committee.

Sample size: The study material consisted of 100 cases of 200 sets of eyes.

Inclusion criteria: Normal anterior segment, patient with glaucoma having an increase in IOP, glaucomatous field defects and optic disc changes.

Exclusion criteria: anterior segment disorders viz infections like conjunctivitis, viral keratitis, corneal ulcers, corneal opacifications, corneal oedema and uveitis.

Type of study: A cross sectional descriptive study for a period of 12 months.

Procedure: The subjects were divided into two groups. Group A had 168 eyes with emmetropia, myopia and hypermetropia of both sexes. Group B had 32 eyes with frank glaucomatous changes which included Angle closure glaucoma, Lens induced glaucoma, Closure suspect glaucoma in both sexes.

In both the group of patient, 4 % lignocaine was instilled in the eye. Tonometric examination was performed in a uniform sequence in all eyes using a Goldmann application tonometer (GAT) first followed by Schiotz tonometer (ST) with 5.5 gm and ST 7.5 gm weight[3]

For evaluation of the IOP using GAT a fluorescent dye was instilled so that the measurement mires are visible. The tonometer which is mounted on the microscope is illuminated with a beam which is placed at an angle of 45 degrees. The cobalt blue filter is moved into place. The patient is then advised to look straight ahead at the target point and the

tonometer tip is guided to touch the corneal apex. The position of the mires is observed and made sure they are centred in the field of equal size, with the inner surface touching each other. And thereby the pressure from the scale on the knob attached to the side of the tonometer is read.

In case with a Schiotz tonometer, after instillation of the anaesthetic drop, the patient is made to lie down with the nose facing upwards. The base of the tonometer gently rests on the cornea and the movement of the scale is noticed and is compared with the chart. A high scale reading indicates a low IOP and vice versa.

Three consecutive measurements were recorded on each eye and their average was taken. All tonometer were calibrated according to the manufacture's instruction each day before use. The whole database was statistically analysed with reference to the following:

Mean IOP using both the instruments, IOP in different age groups, IOP in both sexes, -IOP in subjects with different refractive status

Statistical analysis was done using Statistical Package for Social Sciences (SPSS version 12.0). Chi square test and t- student test was used to compare the variables.

Significance was considered if $P<0.05$

RESULTS

In our study 200 eyes were taken into consideration and divided into two groups of which, Group A consisted of 168 apparently normal eyes, which included emmetropes, myopes and hypermetropes and Group B comprised of 32 eyes which were frank glaucomatous cases with glaucomatous field defects.

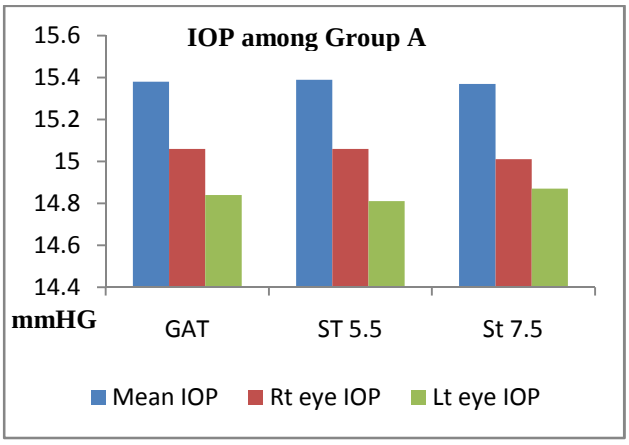

Fig 1: IOP among Group A with different instruments

Figure 1 shows the mean IOP among group A which was 15.30mmHg in GAT, 15.06 mmHg with ST 5.5 and 14.84 mmHg with ST 7.5. Among group B the mean IOP recorded with GAT in males was 38.18 mmHg and 48.43 mmHg in females. With ST 7.5 mean IOP in males showed 36.19 mmHg and 46.28 mm Hg. With regards to the mean IOP between both the eyes, Figure 2 showed that the mean IOP in right eye with GAT was 15.39mmHg, 15.06 mm Hg with ST 5.5. &14.81 mm Hg with ST 7.5. Figure 3 showed that the mean IOP in the left eye with GAT was 15.37 mm Hg, 15.01 mm Hg with ST 5.5 and 14.87 mm Hg with ST 7.5.The IOP difference with GAT was 0.02 higher in the right eye whereas ST 5.5 showed no difference and ST 7.5 showed 0.06 mm Hg higher in left eye.

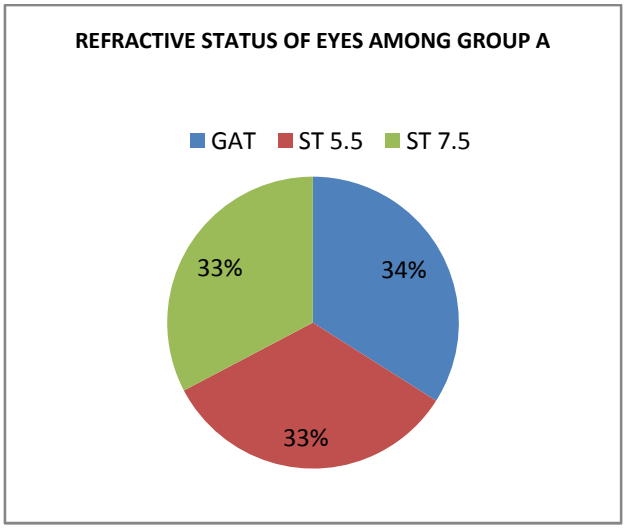

Fig 2: shows the refractive status of the eyes among group A

Figure 2 shows the refractive status of the eye among group A of which 57% were emmetropes, 26% were myopic and 17% were hypermetropics. In Figure 5 it showed that in emmetropes, GAT in right eye revealed 15.10 mm Hg and 15.14 mmHg in left eye. With ST 5.5 it showed 14.88 mm Hg in right eye and 15.01 mm Hg in left eye. With ST 7.5 mean IOP in right eye showed 14.61 mmHg and 14.73 mm Hg in left eye. Figure 4 shows the IOP recorded in 44 myopes with GAT in right eye showed 16.40 mm Hg and 16.40 mm Hg in left eye. With ST 5.5 right eye recorded 15.7 mm Hg and 15.86 in left eye. With ST 7.5, right eye showed 15.4 mm Hg and 15.8 mm Hg in left eye. In Figure 5, among the 28 hypermetropes, GAT in right eye recorded 14.78 mm Hg and 14.42 mm Hg in left eye. With ST 5.5 right eye showed 14.62 mm Hg and left eye showed

13.97mm Hg. With ST 7.5 right eye recorded 14.41 mm Hg and left eye showed 13.85 mmHg Figure 6 shows the sex percentile in study group A with 55 percentile being males and 45percentile being females.

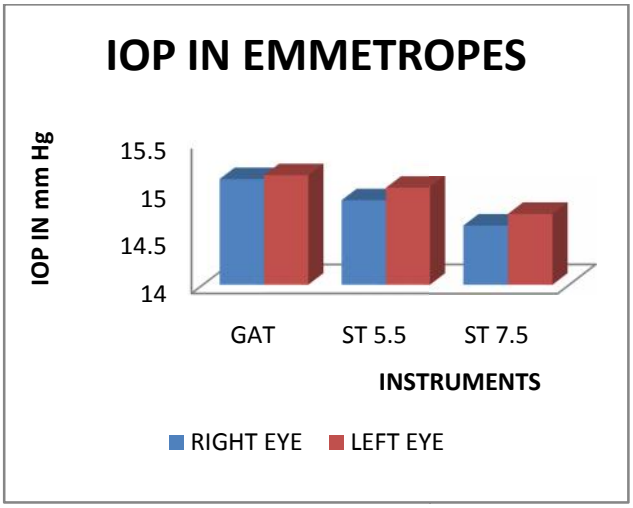

Fig 3: The IOP in Emmetropes

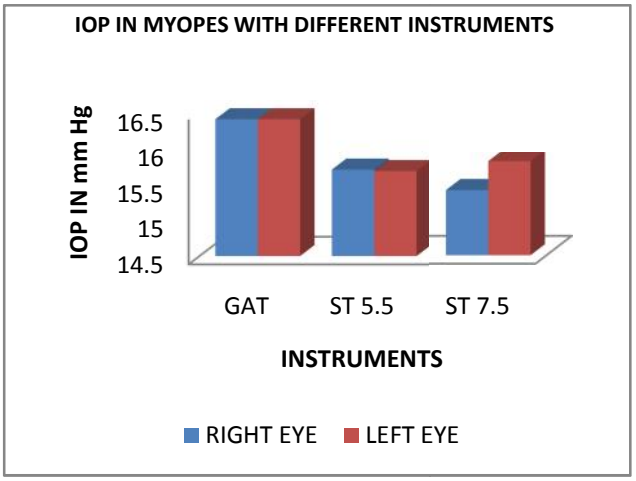

Fig 4: The IOP in myopes

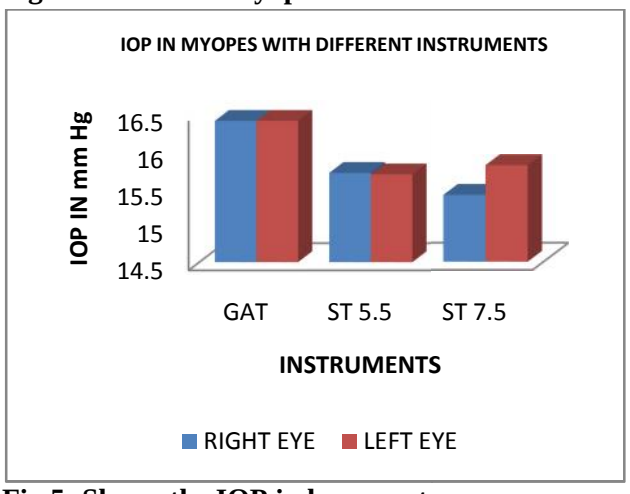

Fig 5: Shows the IOP in hypermetropes

In Figure 7 the mean IOP in both the sexes were estimated. Of the 76 males and 92 females, GAT recorded 15.17 mm Hg in males, 15.55 mm Hg in females. With ST 5.5 males showed 14.9 mm Hg and females showed 15.19 mm Hg. With ST 7.5, males showed 14.56 mm Hg and females recorded 15.06 mm Hg. Thus while comparing it revealed that females have higher mean IOP than males with both GAT and ST

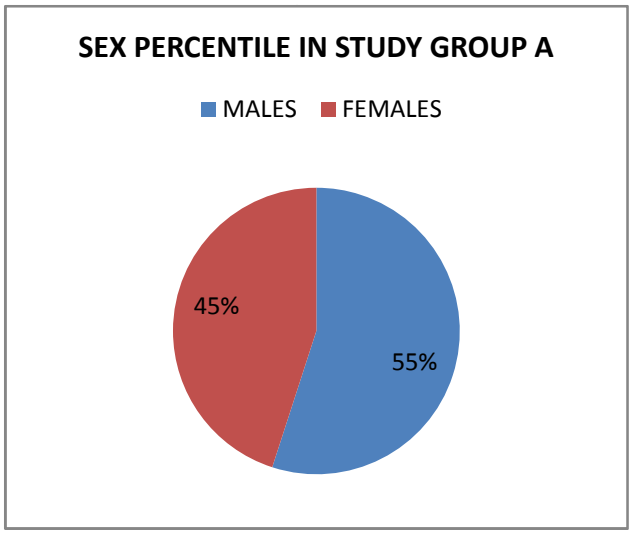

Fig 6: Sex percentile in group A

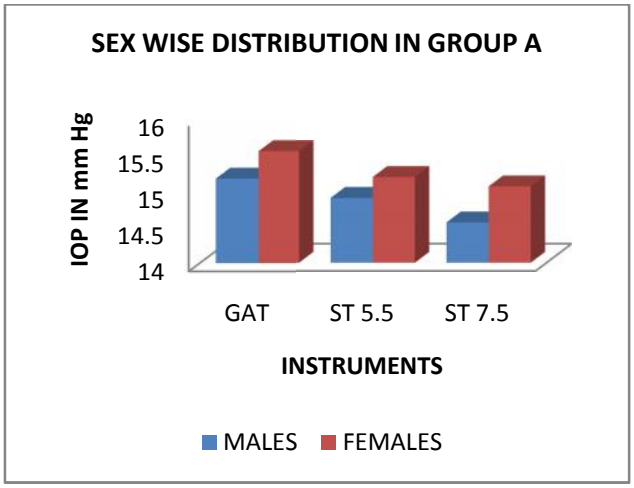

Fig 7: The mean IOP among both the sexes.

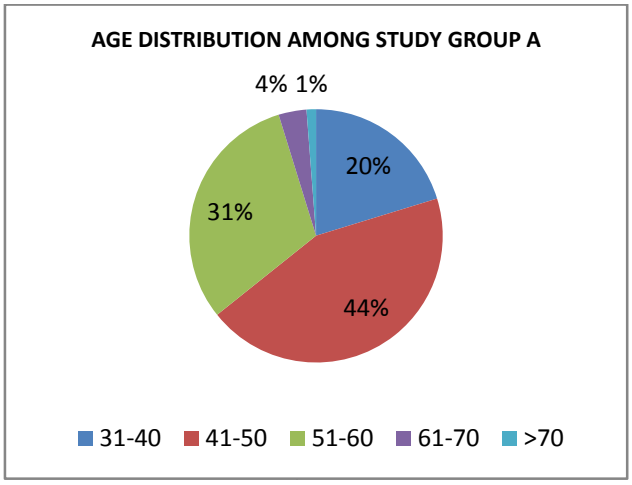

Fig 8: Age distribution among study group A

Figure 8 shows the number of subjects in the different age categories. In the age group 31-40 yrs 34 eyes were evaluated, with 74 eyes in the age group 41-50 years, 52 eyes in the age group 51-60 years, 6 eyes between 61-70 years and above 70 years 2 eyes were evaluated for.

Figure 9hows the age wise difference in mean IOP with both GAT and ST. In 31-40 yrs age group, it showed 14.88 mm Hg, 14.63 mm Hg and 14.52 mmHg with GAT, ST5.5 and ST 7.5 respectively. In 41 to 50 age group it was 14.9 mm Hg, 14.56 mm Hg 14.25 mm Hg with GAT, ST 5.5 and ST 7.5 respectively.In 51 to 60 yrs age group, it was 16.43 mm Hg, 15.73 mm Hg and 15.55 mm Hg with GAT, ST 5.5 and ST 7.5 respectively. In 61 to 70 yrs it was 17.4 mm Hg, 16.80 mm Hg, 15.93 mm Hg with GT, ST 5.5 and ST 7.7 respectively. And above 70 yrs it showed 21 mm Hg, 20,6 mm Hg, 21.9 mm Hg with GAT, ST 5.5 and ST7.5 respectively.

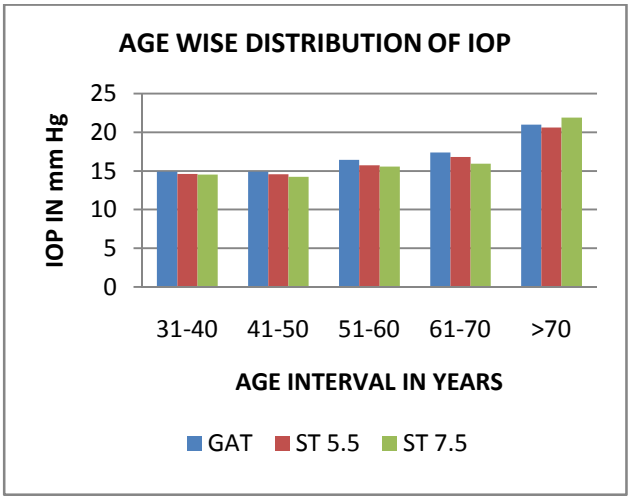

Fig 9: The Mean IOP in different age groups with GAT AND ST

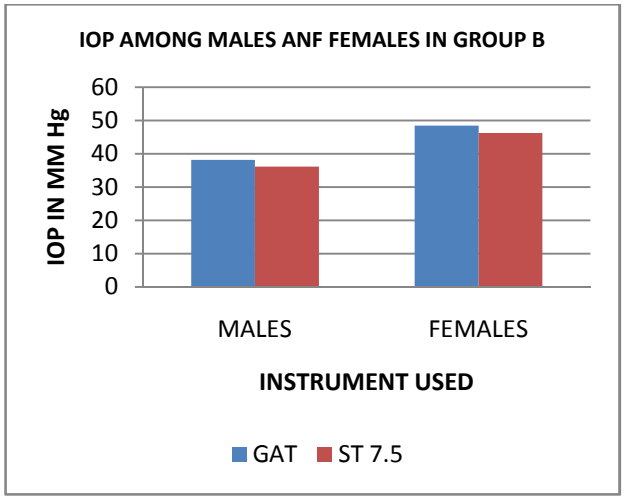

Fig 10: Mean IOP among males and females in group B

Figure 10 shows the mean IOP among males and females in group B using both ST and GAT

DISCUSSION

Glaucoma initially was defined as an increase in IOP resulting in damage to the visual system and thus causing irreversible blindness. Various instruments used for measuring IOP vary in terms of the design, mechanism and accuracy. However the GAT tonometer is considered as a gold standard in measuring IOP

However, there is a controversial study about the relationship between blood pressure and the intraocular pressure. Some studies have shown that low blood pressure predisposes to low ocular perfusion pressure (OPP), which can increase the chance of hypoxic or ischemic stress. This correlates with the nocturnal IOP elevations and blood pressure dips. Although the role of low blood pressure in glaucoma is clearly detrimental, the effect of high blood pressure is still more complex. In the short term however, the high blood pressure can improve the OPP and provide some protection against the IOP induced ischemia

Recent studies have shown that on lowering the ocular perfusion pressure, the chances of visual field loss can be reduced. The OPP is largely determined by cardiovascular fitness.

While checking the calibration error one must be attentive. It is noted that the calibration check bar should be positioned with the long arm towards the examiner while changing the settings, since the GAT is based on a balancing principle. The intra observer and the inter observer agreement in the measurement of calibration error of GAT is rarely reported in literature.

A number of western studies were done like the Armaly [9] which recorded a mean IOP of 16.22mmhg, Goldmann and Schmidt recorded a mean IOP of 15.45mmhg. In our study a mean IOP among group A with GAT revealed 15.30 mm Hg, with ST 5.5 as 15.06 mm Hg and with ST 7.5 as 14.84 mm Hg.

Comparing the readings of GAT and ST in population a study was conducted and according to Bayard there was a close relation between GAT and ST. Bawton Smith et al[10] showed GAT recorded a higher value than ST in 84% of the eyes and the difference between the two tensions was less than 1 mm Hg. Mansoor F and Armaly MD[11,12,13](1966) compared

GAT and ST and concluded that the difference was due to co efficient of ocular rigidity and position of the patient. In this study GAT revealed a higher value in apparently normal eyes and the average difference between GAT and ST being 0.24 mm Hg.

Comparing mean IOP between right and left eye, Davanger[14] showed that the difference in mean IOP of the two eyes of the same individual had no difference in nearly 46% of the population and a difference of less than 3 mm Hg in the remainder. In our study, the mean IOP of the 2 eyes, GAT revealed a higher value of 0.02 in right eye; ST5.5 revealed no difference and ST 7.5 showed 0.07 higher values in the right eye.

Comparing IOP in subjects with different refractive status. Badlani and Telang, 15,[16] showed a mean IOP higher in myopes which was between 13-19 mm Hg. This study showed that myopes had a higher IOP with GAT recording a value of 16.4 mm Hg, ST 5.5 as 15.8 mm Hg and ST 7.5 as 15.4 mm Hg. Comparing IOP in reference to the sexes Bankes[17] recorded a mean IOP in males and females, and females had a higher value between the age group 40-49 and equal value in the age group of 50-59. Our study showed that females had a higher value compared to mean values in males, the value differing less than 1 mm Hg with both GAT and ST. Comparing IOP in different age groups, Bengtsson B [18]compared GAT and ST, revealed that both gave similar values till the age of 50 years and with advancing age GAT revealed higher values than ST. Our study showed an increase in IOP with increasing age, GAT revealing higher values, and with more difference in mean IOP with ST as age progresses.

Some of the advantages of GAT are that it is repeatable, less dependent on sclera rigidity and hence it is more accurate than Schiotz, most commonly used tonometer in the world, and allows comparability of readings, usable readings obtained in nystagmus. Disadvantages include difficulty in sterilising the tip, condoms and disposable tips reduce the accuracy, must be a slit lamp mounted with the patient in an upright position and expensive

Limitations of the study: In all mechanical tonometers certain amount of instrumental error are bound to occur due to friction and mechanical faults. Some amount of extra ocular muscle contraction occurs when the tonometer is placed on the eye and this can cause an increase in the IOP. However accommodation has a reverse effect since the contraction of the ciliary muscles will cause an increase in the outflow of the aqueous and reduce the IOP.

Certain amount of resistance is offered by the eyeball to a change in the intra ocular volume, which manifests as a change in the IOP. The distensibilty of the eyeball is small, thus when the volume increases by 0.1% the IOP rises between 20-30mmhg, however such measurements can be recorded accurately only by a manometer.

CONCLUSION

In the study that was conducted it was observed that the IOP measured with GAT was more accurate and higher value than ST. The values also correlated with the true intra ocular pressure. With respect to the difference in the IOP between the two eyes, the mean IOP did not show any significant difference with both GAT and ST. Regarding the refractive status, myopes showed a higher mean IOP than emmetropes and hypermetropes. Considering the sex difference, with both GAT and ST females had a higher reading. With respect to age, the mean IOP increased with age. Group B studies which had frank glaucoma cases showed that the IOP measured with GAT was higher and more accurate to the actual IOP value whereas the readings with Schiotz were variable and unreliable.

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