Comparison of between Primary Open Angle glaucoma (POAG) and Ocular Hypertension (OHT) with special reference to mean Central Corneal Thickness (CCT)

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Abstract— *Glaucoma is the leading cause of irreversible blindness worldwide and is second only to cataract as the most common cause of blindness overall. Ocular Hypertension is the precursor of glaucoma. Central Corneal Thickness (CCT) is an important factor which is assessed to know the prognosis in management of the already diagnosed cases of glaucoma are assessed and Ocular Hypertension is pre glaucoma stage so this study was conducted to compare Central Corneal Thickness (CCT) Open-angle glaucoma (OAG) and Ocular Hypertension (OHT) cases. This study was conducted on 30 OAG and 30 OHT cases. It was observed that CCT is significantly lowered in OAG cases than OHT cases.*

Keywords: Open-angle glaucoma (OAG) and Ocular Hypertension (OHT), Central Corneal Thickness (CCT).

I. INTRODUCTION

Glaucoma affects more than 67 million persons worldwide, of whom about 10%, or 6.6 million, are estimated to be blind[1]. Glaucoma is the leading cause of irreversible blindness worldwide and is second only to cataract as the most common cause of blindness overall[1].

In India, the estimated number of cases of glaucoma is 12 million, around one fifth of the global burden of glaucoma.[2] Glaucoma is an optic neuropathy with the characteristic appearance of an optic disc and a specific pattern of visual field defects, that is associated frequently but not invariably with a raised IOP.[3]

The term ocular hypertension was advocated in the 1970s to distinguish persons with 'normal' intraocular pressure (IOP) (i.e., =21 mm Hg) from those with an IOP greater than 21 mm Hg, who were considered to be at increased risk for open angle glaucoma[4,5]

Intraocular pressure (IOP) - The normal IOP can be defined as that pressure which is compatible with normal health and function of the eye. It is that pressure, which if maintained does not lead to glaucomatous damage of the optic nerve head. Elevated intraocular pressure (IOP) is a positive risk factor for the development of glaucomatous optic nerve damage and visual field loss.[6] Goldmann Applanation Tonometry (GAT) has been considered to be the gold standard for determining the IOP.

Glaucoma is diagnosed with presence of either optic nerve changes or visual field changes along with increase IOP. When IOP is raised without any visual field changes and optic nerve changes then it is Ocular Hypertension.

Open-angle glaucoma (OAG) is the most common type of glaucoma. In open-angle glaucoma, slow damage to the nerve in the back of the eye (optic nerve) causes gradual loss of eyesight. At first, the

person loses side or outer (peripheral) vision. If open-angle glaucoma is not treated, vision loss continues until total blindness develops.

Central Corneal Thickness (CCT) is an important factor which is assessed to know the prognosis in management of the already diagnosed cases of glaucoma are assessed and Ocular Hypertension is pre glaucoma stage so this study was conducted to compare Central Corneal Thickness (CCT) Open-angle glaucoma (OAG) and Ocular Hypertension cases.

II. METHODOLOGY

This comparative study was conducted at Department of Ophthalmology, attached to S.M.S. Medical College, Jaipur (Rajasthan) in year 2017 to compare mean Central Corneal Thickness (CCT) among Primary Open Angle glaucoma (POAG) and Ocular Hypertension (OHT).

This study was conducted on 30 confirm cases of Primary Open Angle Glaucoma (POAG) and 30 confirms cases of Ocular Hypertension (OHT)

Primary Open Angle Glaucoma (POAG) i.e. untreated IOP of greater than 21mmHg, with an evidence of optic nerve cupping and corresponding visual field defect.

Ocular Hypertension (OHT) i.e. untreated IOP of greater than 21mmHg, with a normal optic nerve head and normal visual fields.

All the study subjects were without Corneal pathology, previous ocular surgery, ocular trauma, ocular infections or any other systemic diseases.

After taking written informed consents of all subjects, all the subjects were interrogated for detailed ocular and systemic histories and they underwent thorough ophthalmic examinations. The preliminary eye examination included the best corrected visual acuity (BCVA) and slit lamp biomicroscopy of the anterior segment, to rule out any corneal pathology and refraction. The intraocular pressure was recorded by using Goldmann Applanation Tonometry (GAT). Two readings were taken and average was calculated. Fluorescein dye is placed in the patient's eye after topical anesthesia to highlight the tear film. A split-image prism is used such that the image of the tear meniscus is divided into a superior and inferior arc. The intraocular pressure is taken when these arcs are aligned such that their inner margins just touch. The IOP (in mm Hg) equals the flattening force (in grams) multiplied by 10. Gonioscopy was done by using a three mirror contact lens to see the type of the angle.

The optic nerve head was examined by using a direct ophthalmoscope to look for any cupping. Then, a detailed evaluation was done by using a 90D magnifying lens after mydriasis. Detailed drawings of the Optic Nerve Head (ONH) were done, that included the area of cupping and pallor in all the quadrants, the position of kinking of the vessels, splinter hemorrhages and peripapillary changes. Indirect ophthalmoscopy was done to look for any peripheral retinal pathology.

The central corneal thickness measured by using an ultrasound pachymeter. The functionality of the pachymeter verified by means of the measurement accuracy test procedure prior to performing actual measurements. After this probe sensitivity test was done. The measurement bias was preset to 100%. The corneal velocity was preset to 1636 m/s. It has acceptance Angle of 10^{o} as no reading was accepted where the angle of the probe to the cornea fluctuates by more than $\pm 10^{o}$. Pachymeter probe tip was clean and dry. When Patient was in Sitting Position the pachymeter tip was placed perpendicularly on the

cornea and it was centered over an undilated pupil. In this an ultrasound image forms which translates into a corneal thickness measurement. Each reading which is obtained actually consists of the average obtained from individual measurements. From each eye, 3 readings were taken and the average was calculated.

The visual fields were assessed by automated static perimetry by using Swedish Interactive Threshold Algorithm (SITA) Standard central 30-2 Threshold Program after making the necessary refractive corrections. The intensity of SITA's initial stimulus presentation at each test location corresponds to the intensity associated with the highest probability of being seen by an age-matched individual. Depending on the patient's response to this first stimulus, the intensity of each subsequent presentation is modified. This iterative procedure is repeated until the likely threshold measurement error is reduced to below a predetermined level, with at least one reversal occurring at every test location. SITA also uses neighborhood comparisons to optimize the best guess procedure: if adjacent test locations show lower or higher sensitivity than expected, the initial stimulus intensity is altered. SITA monitors the timing of patient responses in order to interactively pace the test. The most common types of visual field deficits in glaucoma result from damage to the nerve fibers in a given location and distribution.

Retinal nerve fiber layer thickness was noted by spectral domain Optical Coherence Tomography (OCT). Readings were taken in similar manner by a single observer.

Correction of the IOP based on the CCT-

The measured IOPs were corrected by using the linear correction formula[7]

$$\text{Corrected IOP} = \text{Measured IOP} - \frac{(\text{CCT} - \text{Reference CCT}) \times 2.5}{50}$$

Correction factor was used is 2.5.

Statistical analysis: Categorical data was expressed as proportion and difference in proportion was analyzed using Chi square test. Quantitative data was expressed as mean and standard deviation and the difference in mean between two groups was inferred using unpaired 't' test. Statistical significance was kept at $p<0.05$. All statistical analysis was done using Epi info version 7.2.1.0 software.

III. RESULTS

Most (36.7%) of the study subjects belong to 41-50 years age group followed by >50 years age group (33.3%). And majority of study subjects were males (70%).

Both groups i.e. POAG group and OHT group were almost similar in age and sex wise distribution ($p>0.05$). (Table 1)

Table 1
Comparison of Age and sex wise distribution in POAG and OHT groups (N=60)

Variables		POAG (N=30)	OHT (N=30)
Age group (in Years)	<30	2	5
	31 – 40	6	5
	41 – 50	8	14
	>50	14	6
	P Value LS	P = 0.134 **NS**	
Sex	Females	11	7
	Males	19	23
	P Value LS	P = 0.398 **NS**	

Best corrected visual acuity (BCVA) among study groups were compared it was found that the mean BCVA in right eye was lower in POAG group (0.40) as compared to OHT group (0.08) which was found e statistically significant (P<0.001). Likewise the mean BCVA in left eye was also found to be significantly lower in POAG group (0.38) as compared to OHT group (0.09); (P<0.001). (Table 2)

Table 2
Comparison of best corrected visual acuity (BCVA) among study groups (N=60)

Eye	POAG (N=30)	OHT (N=30)	P value LS
OD	0.40 ± 0.23	0.08 ± 0.09	<0.001 S
OS	0.38 ±0.23	0.09 ± 0.12	<0.001 **S**

Regarding IOP, the mean IOP in right eye was higher in POAG group (27.4mmhg) as compared to OHT group (24.1mmhg) and this difference was found statistically significant (P<0.001). Likewise the mean IOP in left eye was also higher in POAG group (27.9mmhg) as compared to OHT group (24.3mmhg), this difference was also found statistically significant (P<0.001). (Table 3)

Table 3
Comparison of Intra-ocular Pressure (IOP) among study groups (N=60)

Eye	POAG (N=30)	OHT (N=30)	P value LS
OD	27.4 ± 2.92	24.1 ± 1.4	<0.001 S
OS	27.9 ± 2.94	24.3 ± 1.39	<0.001 **S**

The mean C:D ratio in right eye was higher in POAG group (0.65) as compared to OHT group (0.33) and this difference was found statistically significant (P<0.001). The C:D ratio in left eye was also found to be significantly higher in POAG group (0.66) as compared OHT group (0.33) as revealed by t test (P<0.001). (Table 4)

Table 4
Comparison of mean C:D ratio among study groups (N=60)

Eye	POAG (N=30)	OHT (N=30)	P value LS
OD	0.65 ± 0.13	0.33 ± 0.05	<0.001 S
OS	0.66 ± 0.13	0.33 ± 0.048	<0.001 **S**

When Central Corneal thickness (CCT) was compared among the study groups it was found that the mean CCT in right eye was higher in OHT group (568.4µ) as compared to POAG group (515µ) and this difference was found to statistically significant (P<0.001). The CCT in left eye was also found to be significantly (p<0.001) higher in OHT group (562.2µ) as compared to POAG group (517.5µ). The mean CCT of both eyes was higher in OHT group (565.3µ) as compared to POAG group (516.3µ). (Table 5)

Table 5
Comparison of of Central Corneal thickness (CCT) among study groups (N=60)

Eye	POAG (N=30)	OHT (N=30)	P value LS
OD	515 ± 28.5	568.4 ± 16.1	<0.001 S
OS	517.5 ± 30.8	562.2 ± 16	<0.001 **S**

IV. DISCUSSION

Intra ocular pressure (IOP) is a major causative risk factor for the development and progression of glaucoma. It is also an important parameter in the diagnosis and follow-up of glaucoma. Central corneal thickness is an important factor which has to be evaluated when the target IOP levels for the management of the already diagnosed cases of glaucoma are assessed and also during the follow up.

In present study, the mean IOP in right eye & left eye was higher in POAG group (27.4 & 27.9mmhg) as compared to OHT group (24.1 & 24.3mmhg) and this difference as found to statistically significant (P<0.001) in both eye. The average IOP was higher in POAG group (27.7mmhg) as compared to OHT group (24.2mmhg) and this difference was statistically significant (P<0.001). However, with the current understanding of IOP as a causative risk factor for glaucoma and that a thin central cornea confers an increased risk for POAG, recent studies using regression analysis of multiple covariates found that black race is not an independent risk factor, although black individuals tend to have thinner corneas, greater cup disc ratios, and higher IOP, which increase their risk (Friedman DS 2004).[8]

Regarding Central Corneal thickness (CCT) it was found that the mean CCT in right eye was higher in OHT group (568.4μ) as compared to POAG group (515μ) and this difference was found to statistically significant (P<0.001). The CCT in left eye was also found to be significantly (p<0.001) higher in OHT group (562.2μ) as compared to POAG group (517.5μ). The mean CCT of both eyes was higher in OHT group (565.3μ) as compared to POAG group (516.3μ)

Central corneal thickness was the most consistent predictor of degree of glaucomatous damage as measured by the outcome variables. It has been suggested that a thicker CCT may be protective against glaucomatous damage, since CCT in ocular hypertensive patients tends to be thicker than in POAG patients.[9,10]

The European Glaucoma Prevention Study[11] also had similar findings, with CCT found to be a powerful predictor for the development of POAG independent of IOP.

Similarly Early Manifest Glaucoma Trial,[12] found that thinner CCT significantly predicted progression of visual loss in patients with POAG.

Herndon LW et al (1997)[13] concluded that the mean CCT is increased in eyes with ocular hypertension when compared with normal or glaucomatous eyes, which confirms the findings of other investigators. Increased CCT may give an artificially high IOP measurement by applanation tonometry.

Copt RP, Thomas R, Mermoud A. (1999)[14] found that there was no significant difference in CCT between controls (552 +/- 35 microns) and patients with POAG (543 +/- 35 microns), but the CCT in the group with NTG (521 +/- 31 microns) was significantly lower than that in the control group or the group with POAG (P < .001), and the CCT in the group with OHT (583 +/- 34 microns) was significantly higher than in controls or patients with POAG (P < .001).

Ocular Hypertension Treatment Study (OHTS)[15] showed that CCT was the strongest predictive risk factor for progression from ocular hypertension and pre perimetric glaucoma to POAG (independent of the influence of IOP), greater severity of visual field damage and more rapid progression of established visual field loss. Patients with a CCT of 555μm in the ocular hypertension treatment study (OHTS) had a 3-fold increase in the risk of glaucoma development compared with those having CCT of ≥ 588μm.

The American Academy of Ophthalmology[16] found strong and consistent evidence that central corneal thickness is a risk factor for progression from ocular hypertension to primary open-angle glaucoma, confirming the OHTS findings.

V. CONCLUSION

This present study concluded that Central Corneal Thickness (CCT) is significantly lowered in Open-angle glaucoma (OAG) cases than Ocular Hypertension (OHT) cases. Thus the measurement of the central corneal thickness aid the ophthalmologist in making a correct diagnosis and in a better management of glaucoma and the glaucoma suspects, especially when their corneal thickness differs markedly from the normal thickness.

CONFLICT OF INTEREST

None declared till now.

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