Original Research Paper

Volume-9 | Issue-12 | December - 2019 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Ophthalmology

TO STUDY THE RETINAL NERVE FIBER LAYER CHANGES IN PRIMARY OPEN ANGLE GLAUCOMA ON OPTICAL COHERENCE TOMOGRAPHY.

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ABSTRACT

BACKGROUND : Primary open angle glaucoma is one of the common causes of visual loss in our society. Though there are several evaluation techniques to diagnose these cases, early detection and assessment of the severity of the disease is of prime importance to manage patients of POAG at an early stage of progression. Most of the early changes that occur in POAG are not detected earlier, hence diagnostic tests such as Perimetry and OCT have proven to be most useful in identifying early damage in the eyes of POAG patients.

METHODOLOGY : A total of 90 patients with established POAG were examined at Tertiary Care Hospital in Western Maharashtra, India on out-patient basis under a descriptive cross-sectional study. All these cases were assessed for symptoms and signs of POAG and further evaluated for severity of progression of the disease as mild, moderate or severe cases. After thorough testing, interpretations of automated perimetry and OCT were compared to find out which test had better sensitivity and specificity in their results. The changes in RNFL were observed and noted quadrant-wise, further categorizing them into stages of POAG as mild, moderate and severe. 10 normal patients were included in the study as control cases.

RESULTS : Incidence of POAG in this study was more in males (60%) than females (40%). OCT showed higher sensitivity, specificity & area under curve in ROC than perimetry (97.22%, 95%, 0.998 vs. 92.78%, 90%, 0.942 respectively), which suggests that OCT is a more accurate diagnostic test for detection of glaucoma as compared to perimetry.

CONCLUSION : This study elaborates the need for awareness regarding possible risk factors contributing to POAG and thereby initiating early detection and thereby early management of the disease. OCT seems to be an accurate, simple and high sensitivity test in early detection of POAG and progression of the disease.

KEYWORDS : Rnfl, Poag, Oct.

INTRODUCTION :

Glaucoma can clinically be considered as a progressive optic neuropathy in which loss of retinal ganglion cells and optic nerve head damage occurs, resulting in visual field defects, thinning of the retinal nerve fiber layer, eventually leading to complete loss of vision.[1,2,3] Glaucoma is considered to be one of the major ocular diseases responsible for visual loss in the world. Primary Open Angle Glaucoma(POAG) is the commonly seen glaucoma that affects almost 6.48 million population.[4,5] It is a bilateral, progressive, painless loss of vision and asymptomatic in early cases. Hence, the peripheral visual field loss in patients with POAG goes unnoticed and does not get evaluated at an early stage. Identification of progression is of utmost importance as the glaucomatous visual field loss is largely irreversible and early detection and appropriate treatment measures can slow down the impact of the disease and help preserve the vision.[6,7,8]

Retinal Nerve Fiber Layer(RNFL) changes are the earlier signs of POAG, followed by Visual field defects (VFD) and Optic Nerve Head (ONH) changes.[9] The RNFL is composed of three components – retinal ganglion cell (RGC) axons, neuroglia and astrocytes. The arrangement of these ganglion cells is the thickest in the macula and just a single cell thick outside the macula. Therefore, early detection of changes in the RNFL and its progression are an important and vital component in glaucoma management.[10]

Optical Coherence Tomography (OCT) is a non-contact, non-invasive and objective mode of imaging technique that shows a high resolution , accurate, cross-sectional image result revealing all the components of the RNFL. OCT provides a quantitative measurement of RNFL thickness in microns by measuring echo time delay with the use of interference patterns of reflected laser light from different retinal layers. Thinning of this RNFL due to loss of ganglion cells is an early sign in POAG and is thus a vital parameter in early detection of the disease. [11,12,13]

Earlier, time domain (TD)-OCT was considered a standard structural imaging test validated for study of Retina and Glaucoma assessment. The TD-OCT had limitations that included low resolution, resulting in 2-dimensional (2D) images and slow acquisition speeds. Over the years, an advanced spectral domain (SD-OCT) was introduced to achieve ultrahigh resolutions and acquisition speeds. Faster scanning speed led to minimal susceptibility to eye movement artefacts, thereby having theoretical advantages over the TD-OCT in glaucoma assessment.[9,14,15]

Recently, OCT is proving to be one of the most valuable tests in early detection of Glaucoma and with it's high resolution and measurement reproducibility , it has the potential of becoming a significant tool in initiation of early glaucoma management.[16]

To the best of our knowledge, there has been no study done on evaluation of changes in the RNFL of patients with Primary Open Angle Glaucoma (POAG) on OCT in Western Maharashtra. The results of this study will help us better manage our patients of glaucoma.

AIM AND OBJECTIVES :

AIM :

To study the Retinal Nerve Fiber Layer (RNFL) changes in Primary Open Angle Glaucoma (POAG) on Optical Coherence Tomography (OCT).

OBJECTIVES :

1. To study the risk factors in patients with POAG.
2. To study the RNFL changes in patients with POAG on OCT.

MATERIALS AND METHODS :

PLACE OF STUDY AREA:

The study was conducted at a tertiary care research centre in Western Maharashtra.

STUDY DESIGN: Descriptive cross-sectional study

SAMPLE DESIGN:

I. Sample size: 100
II. Sampling unit: Sampling unit was “individual”

III. Sampling technique: Convenient Sampling technique
IV. Inclusion Criteria of POAG:

Primary open-angle glaucoma (POAG) is defined as an optic neuropathy that is multifactorial, chronic, progressive, and irreversible. It is characterized by acquired optic nerve fiber loss which develops along with open anterior chamber angles, characteristic visual field defects and high intraocular pressure for a healthy eye. It manifests large cup: disc ratio, without any other known causes of the disease and is usually present bilaterally. [17,18] We have included 10 normal patients as control cases in this study.

We have includedpatients of POAG with following findings:
- Bilateral involvement of eyes
- Age group >20 years.
- Normal anterior segment on slit-lamp examination.
- Intraocular pressure more than 21 mmHg with Goldmann Applanation Tonometry.
- Typical glaucomatous cupping (Vertical cup: disc ratio >

0.5:1 or asymmetry between two eyes of >0.2), neuroretinal rim thinning, notching, excavation or RNFL defect noted on clinical stereoscopic fundus examination.
- Anterior chamber open angle on Gonioscopy.

V. EXCLUSION CRITERIA:
- Corneal dystrophies
- Contact lens users
- Known case of corneal disease
- History of previous intro-ocular surgery
- Presence of ocular infection
- Presence of corneal surface injury

DATA COLLECTION:
Based on the selection criteria, patients attending outpatient department (OPD) were screened for eligibility. All those who fulfilled the inclusion criteria were eligible to participate in the study. The purpose of the study was explained to patients. Informed written consent were taken prior to actual participation of patient into the study, informed consent form (Annexure A) includes all necessary information to conduct the study.

Thorough history was taken and clinical examination was performed for all patients and findings were recorded on predesigned and pretested proforma (Annexure B).
- Demographic factors like age, sex, occupation and address was recorded as per the Annexure B.
- Complete ophthalmic and medical history was taken.
- Visual acuity was measured using Snellen's chart.
- Slit Lamp Examination was done for microscopic examination of eyes (Figure 5)
- Intraocular pressure was recorded using Goldmann Applanation tonometer.
- Gonioscopy was done with Goldmann single mirror to evaluate anterior chamber angle.
- Fundus examination was performed after dilation of pupil.
- Specular microscopy (non-contact SP 3000P) was done to study the endothelial morphology.
- Pachymetry was done to assess the corneal thickness
- Perimetry was done using Humphrey visual field analyzer (Figure 6). Patients with POAG were classified into mild, moderate and severe cases on basis of the following:

1. Mild or Early stage Glaucoma:
- Optic nerve abnormalities consistent with POAG
- No visual field abnormalities on any visual field test

2. Moderate stage Glaucoma:
- Optic nerve abnormalities consistent with POAG
- Glaucomatous visual field abnormalities in one hemi field
- Not within 5 degrees of fixation (5 degrees involvement of spots nearest fixation)

3. Severe or advanced stage Glaucoma:
- Optic nerve abnormalities consistent with POAG.
- Glaucomatous visual field abnormalities in both hemi field.
- And/or loss within 5 degrees fixation in at least one hemi field.

- Optical Coherence Tomography was performed on Cirrus HD-OCT 500 (Carl Zeiss Meditec, Inc.) on all subjects included in the study after pupillary dilatation by single observer. Good quality OCT scans having single strength more than 7 for analysis of the RNFL changes were taken. (Figure 7)

Patient was allowed to leave the study anytime during the study, if he/she was unwilling to participate in the study.

DATA ANALYSIS :
Data was analyzed using SPSS software 16 version, Microsoft Excel 2007 and MedCalc statistical software version 12.1.1 software**.** Quantitative data are presented as means ± standard deviations (SD). Qualitative data are presented as frequencies.

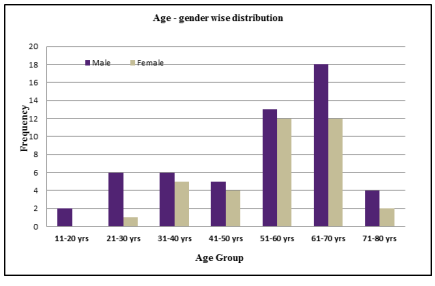
DISCUSSION & INTERPRETATION:
The study findings were discussed taking into consideration the materials, study design, results from the other relevant studies. Conclusions were drawn based on the study and recommendations were made using the results of the present study.

ETHICS:
Institute Ethical Committee approval was taken prior to the study. Consent of the patient was taken only after giving full information about the study. Patient was assured that his/her reports would be kept confidential.

OBSERVATIONS AND RESULTS :
A total of 90 patients who had established Primary Open Angle Glaucoma were examined at a Tertiary Care Hospital in Western Maharashtra. 10 normal patients were used as control cases in the study.

FOLLOWING WERE THE RESULTS OF THIS STUDY:

Graph No.1 Showing age & gender wise distribution of study sample



Graph No. 2 Showing gender distribution of study sample.

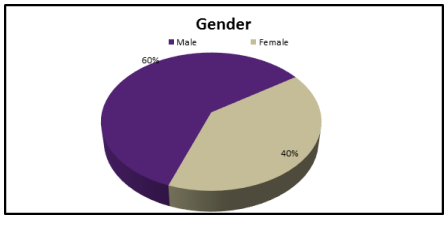
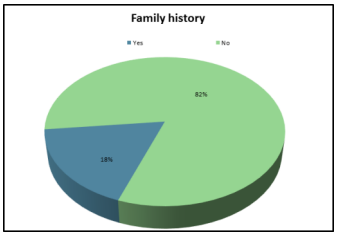


Table No. 1 Representing the mean and standard deviation of age distribution of study sample.

Age (years) Statistics	
N	90
Mean	55.03
Std. Error of Mean	1.55
Std. Deviation	14.71
Range	60
Minimum	20
Maximum	80

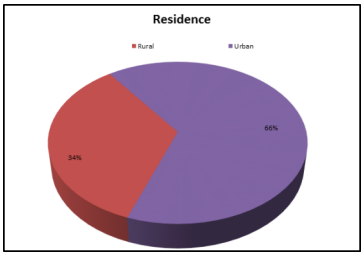
Mean age of study sample was 55.03 years with standard deviation of 14.71 years, with the highest being 80 years and lowest 20 years. There were 36 (40%) females and 54 (60%) males in the study. 30 (33.33%) cases were in the 61-70 years age group followed by 25 (27.78%) in 51-60 years age group.

Graph No. 3 Showing distribution of study sample with and without history of glaucoma.



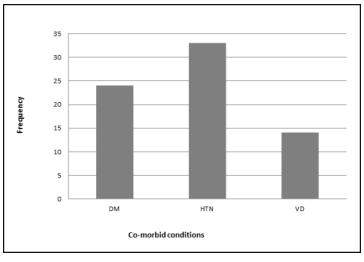
Family history of glaucoma was present in 16 (18%) cases in the study sample, while 74 (82%) were without any family history of glaucoma among the study sample.

Graph No. 4 Showing distribution of areas from where the subjects from the study sample belong.



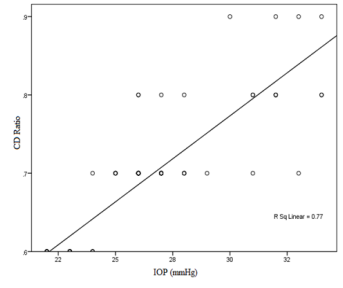
59 (66%) of cases belonged to urban areas, while 31 (34%) belonged to rural regions among the study sample.

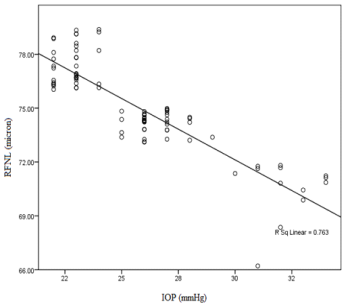
Graph No. 5 Showing distribution of co-morbid conditions among study sample.



33 (36.7%) cases were having hypertension followed by 24 (26.7%) with diabetes mellitus & 14 (15.6%) with cardiovascular diseases in the study sample.

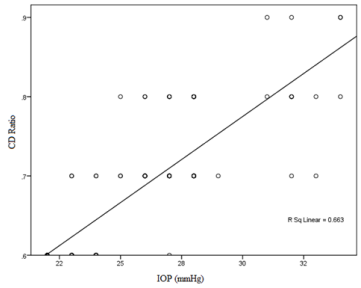
Graph Nos. 6 & 7 Showing correlation between IOP and CD ratio and RNFL respectively in Left eyes of the study sample.





Graph Nos. 8 & 9 Showing correlation between IOP and CD ratio and RNFL respectively in Right eyes of the study sample.

Right Eye



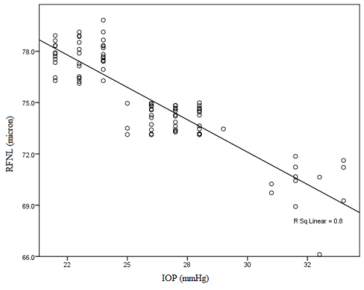


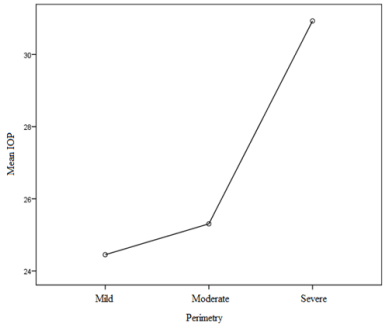
Table No. 2 Showing correlation between IOP with C:D ratio and RNFL in both eyes of study sample.

Correlation between IOP with C:D ratio & RNFL			
Eye	Variables	C:D Ratio	RFNL
Left	Pearson Correlation	0.877**	-0.874**
	Sig. (2-tailed)	**0.000**	**0.000**
Right	Pearson Correlation	0.814**	-0.895**
	Sig. (2-tailed)	**0.000**	**0.000**

Above statistics shows that, there was strong positive correlation between IOP and C:D ratio, which meant an increase in IOP showed an increase in C:D ratio. There was strong negative correlation between IOP and RNFL, showing a decrease in RNFL with an increase in IOP ($p = 0.000$).

Graph Nos.10 & 11 Showing correlation between IOP and Perimetry results in Left eye and Right eye of the study sample respectively.

Left Eye



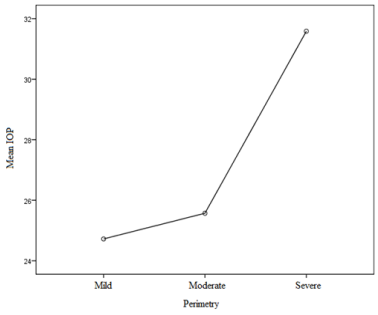


Table No. 3 Showing correlation between visual field defects and mean IOP readings in both eyes of the study sample.

Eye	Visual Field defects	N	Mean IOP	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Left	Mild	40.00	24.45	2.11	0.33	23.77	25.13	22.00	29.00
	Moderate	36.00	25.31	2.58	0.43	24.43	26.18	22.00	34.00
	Severe	14.00	30.93	2.73	0.73	29.35	32.51	26.00	34.00
Right	Mild	36.00	24.72	1.97	0.33	24.06	25.39	22.00	28.00
	Moderate	42.00	25.57	2.67	0.41	24.74	26.40	22.00	32.00
	Severe	12.00	31.58	2.58	0.74	29.95	33.22	26.00	34.00

On application of Anova test, mean of IOP in subjects with severe visual field defects on perimetry was higher than those with mild or moderate visual field defects and the difference was statistically highly significant (p = 0.000)

There was positive correlation between IOP and Visual field defects on perimetry. Increase in IOP showed increase in severity of visual field defects (p = 0.000).

Out of the 180 eyes of POAG, 76 eyes had early stage, i.e, mild glaucoma. 78 eyes had moderate stage glaucoma and 26 had severe, i.e., advanced stage glaucoma.

Graph No. 12 Distribution of RNFL thickness in POAG cases of the study sample

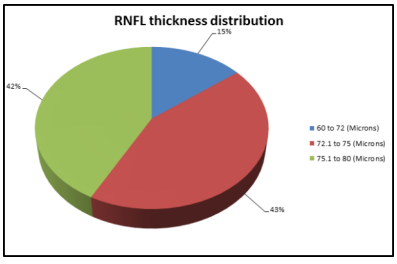


Table No. 4 Showing RNFL thickness distribution (in microns) seen in mild, moderate and severe cases of POAG in study sample.

Sr. No.	RNFL Thickness Range	No. of eyes with POAG with % value	POAG Stages
1	60 to 72 (Microns)	26 (15%)	Severe
2	72.1 to 75 (Microns)	78 (43%)	Moderat
3	75.1 to 80 (Microns)	76 (42%)	Mild

Above Pie diagram and table show the RNFL thickness in mild, moderate and severe POAG. 76 eyes (42%) had mild glaucoma with a RNFL thickness of 75.1 to 80 microns, 78 eyes (43%) had moderate glaucoma with a RNFL thickness of 72.1 to 75 microns and 26 eyes (15%) had severe glaucoma with a RNFL thickness of 60 to 72 microns.

Graph No. 13 Showing RNFL thinning quadrant-wise distribution in POAG cases of the study sample.

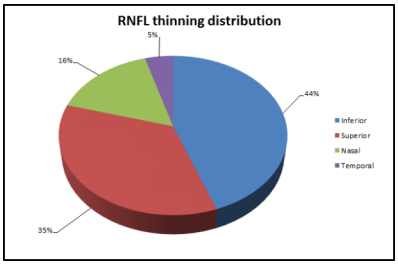


Table No. 5 Showing quadrant-wise RNFL thinning distribution in POAG cases of the study sample.

Sr. No.	Quadrant	No. of eyes with POAG with % value
1	Inferior	80 (44%)
2	Superior	63 (35%)
3	Nasal	29 (16%)
4	Temporal	8 (5%)

Above Pie diagram and table show RNFL thinning quadrant-wise distribution in POAG cases of the study sample. It is seen that 80 eyes (44%) of POAG cases showed RNFL thinning in the inferior quadrant, 63 eyes (35%) showed thinning in the superior quadrant, 29 eyes (16%) showed thinning in the nasal quadrant and 8 eyes (5%) showed thinning in the temporal quadrant.

Table No. 6 Showing distribution and percentage values of results derived from OCT.

Cross-tabulation					
			Disease		Total
			Negative	Positive	
OCT	Negative	Count	19	5	24
		% within sample	95%	2.78%	12%
	Positive	Count	1	175	176
		% within sample	5%	97.22%	88%
Total	Count	20	180	200	
	% within sample	100.0%	100.0%	100.0%	

Sensitivity = True Positive / (True Positive + False Negative) = 175 / 175+5 = 0.9722 (97.22%)

Specificity = True Negative / (True Negative + False Positive) = 19 / 19+1 = 0.95 (95%)

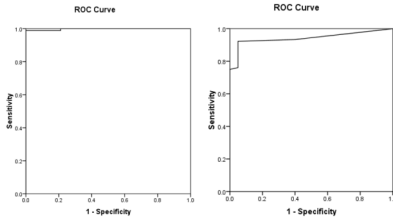
Table No. 7 Showing distribution and percentage values of results derived from Perimetry.

Cross-tabulation					
			Disease		Total
			Negative	Positive	
Perimetry	Negative	Count	18	13	31
		% within Biopsy	90%	7.22%	15.5%
	Positive	Count	2	167	169
		% within Biopsy	10%	92.78%	84.5%
Total	Count	20	180	200	
	% within Biopsy	100%	100%	100%	

Sensitivity = True Positive / (True Positive + False Negative) = 167 / 167+13 = 0.9278 (92.79%)

Specificity = True Negative / (True Negative + False Positive) = 18 / 18+2 = 0.90 (90%)

Graph Nos. 14 & 15 (left to right) Showing area under Receiver Operator curve (ROC) for OCT and Perimetry repectively.



Test	Sensitivity	Specificity	ROC area
OCT	97.22 %	95 %	0.998
Perimetry	92.78 %	90 %	0.942

Above table shows that OCT had higher sensitivity, specificity & area under curve in ROC than perimetry, which suggests that OCT was more accurate for detection of POAG than perimetry.

DISCUSSION :

Primary open angle glaucoma (POAG) is the most frequently seen glaucoma in most of the population of the world and is often termed as "the silent thief of vision" as it is an asymptomatic condition that leads to blindness without eliciting warning signs until advanced stage.[19] Thus, a key role of preventing glaucoma blindness includes screening individuals in the early stages of the disease, before they develop blindness. Glaucoma causes irreversible loss of vision, thereby leading to severe disability, which will directly affect social and economic growth in the population.

Glaucoma is described as the second leading cause of blindness in the world. The main element of glaucoma management is to diagnose this disease in its early stage when it is asymptomatic. Visual field testing is one of the diagnostic tests for glaucoma. But, it is studied that standard perimetry cannot detect VF defects until 20% - 40% of ganglion cell loss.[20] Hence, recently, RNFL defects have been objectively demonstrated earlier than VF defects with new technologies. Measuring RNFL thickness by OCT gives an objective and quantitative assessment of glaucomatous structural loss. It has been shown that all generations of OCT provide reproducible measurements of RNFL thickness in many previous studies. [21-23] Mwanza et al. showed that Cirrus OCT had very good intravisit and intervisit reproducibility of RNFL thickness and ONH parameters.[24]

There are several risk factors that contribute to development of POAG. We studied the correlation between prevalence of POAG and age, gender, background of the patient – Rural or Urban, Family history of glaucoma, history of systemic diseases like hypertension, diabetes and cardiovascular diseases, intraocular pressure and cup:disc ratio (CDR).

AGE:

Advanced age is an important risk factor for the presence of POAG. The Baltimore Eye Survey showed that the occurence of glaucoma increases significantly with age with about 11% in those aged 80 years or above. In the Collaborative Initial Glaucoma Treatment Study (CIGTS), visual field defects were 7 times more likely to develop in patients aged above 60 years, than in those below 40 years. Studies in Japan have shown a relationship between glaucoma and age with no increase in IOP in the population. Age appeared to be an independent risk factor for the prevalence of glaucoma. The Ocular Hypertension Treatment Study (OHTS) found an increased risk of open-angle glaucoma with age (per decade), of 43% in the univariate analysis and 22% in the multivariate analysis.[25] Mean age of our study sample was 55.03 years with standard deviation of 14.71 years, with the highest being 80 years and lowest 20 years. In our study, 30 (33.33%) samples were from 61-70 years of age group followed by 25 (27.78%) subjects in 51-60 years of age group having POAG.

GENDER :

In our study, there were 36 (40%) females and 54 (60%) males as POAG cases. Some previous studies showed that the glaucoma prevalence is high in men. Barbados study stated that glaucoma was related with men in older age, increased IOP, low systemic BP, positive history of glaucoma in the family, low body mass and low intra ocular tension ratio.[26] The Framingham Eye Study and the Rotterdam Study showed an increased prevalence among males, whereas the Blue Mountains Eye Study showed an increased prevalence among females. [27,28,29] Most of the studies have not been successful in proving the role of gender as a risk factor for POAG with accuracy.

BACKGROUND OF THE PATIENT (RURAL/URBAN) :

As per the Chennai Glaucoma Study, more cases of POAG found in the urban population of Chennai compared to the rural population suggested a possible impact of lifestyle differences and non-communicable diseases such as hypertension and diabetes which are also more prevalent in the urban population.[30] Not many studies have explored other socio-demographic and systemic risk factors till date. In our study, 59 (66%) subjects of glaucoma belonged to urban areas, while 31 (34%) belonged to rural regions. Knowledge about the severity of the disease and urgency of inititation of management , thereby controlling its progression must be there in a given population. Also, for those who belong to rural areas, availability of facilities like Perimetry and OCT and other glaucoma assessment equipments and technologies used at Tertiary Care centre are remote.

FAMILY HISTORY OF GLAUCOMA :

Positive history of family members having glaucoma is a proven risk factor for POAG. The risk of getting glaucoma in first degree relatives is 4–16%.[31] A negative family history of glaucoma could be inaccurate in only ten to sixty percent of patients where glaucoma was diagnosed . When all first degree relatives of patients detected to have glaucoma of open angle primary type from Rotterdam study were examined, 22.4 percent of them were found to have glaucoma. This is nearly 10 times greater than the risk in the general population. A population based twin study calculated the risk of inheritance of POAG to be around 13%. Barbados study showed that one quarter of the siblings of POAG patients had POAG or glaucoma suspect.[32] In our study, family history of glaucoma was present in 16 (18%) of subjects while 74 (82%) were without any family history of glaucoma among the study sample.

One gene (GLCA) has been identified in recent studies in relation with juvenile-onset glaucoma and some (about 3-4%) adult cases of POAG.[33,34] This gene is situated on chromosome 1 in q23-25 region.[30] In about 4% of patients with POAG, three different mutations of this gene have been identified. In India, a specific mutation is found in the abnormal genes seen in about 5% of the total population of glaucoma patients.[35] A new gene that has been linked with adult-onset open-angle glaucoma is located on chromosome 2 (GLC1B).[36] Both of these genes seem to be related to an early-onset type in adults. An Australian study identified another gene abnormality on chromosome 3 which was seen in a Tasmanian family with early-onset open-angle glaucoma. One third of them had myocilin gene mutations and others with glaucoma showed chromosome 3 mutations.[37]

Many ocular factors associated with POAG like IOP, cup-to-disc ratio and VF defects appear to to have a genetic basis. Children and siblings of glaucoma patients are more prone to have abnormal aqeous humour dynamics than first-degree relatives of normal people.[38] Thus, some of the polygenic inheritance of POAG may occur indirectly through these related factors rather than directly through the disease itself.

All these above mentioned studies give us a platform to research and suggest that Primary Open Angle Glaucoma (POAG) may be associated with several different genes, each of which may exhibit a different time of onset and clinical course as well. More clarity may be found in this field over the coming years.

HISTORY OF SYSTEMIC ILLNESS :

Hypertension (HTN) studies on the correlation of HTN and intraocular pressure (IOP) are inconsistent so far. A few epidemiologic studies have carried out research on this correlation and found conflicting reports. Some investigative studies have found that there is a low chance of developing glaucoma in hypertensive individuals,[39] but other researchers have found a significant association between high systemic BP and POAG.[40,41] The Blue Mountains population study showed a linear rise in mean IOP from 14.3 mmHg for systolic BP less than 110 mmHg to 17.7 mmHg for systolic BP more than 200 mmHg.[28] A study involving 4297 subjects >40 years of age in a predominantly white population found a positive correlation between systemic BP and IOP and an association between POAG and systemic hypertension.[42] However, a cross-sectional population study concluded that the association between hypertension and POAG was most likely due to the correlation between age and hypertension.[43] In our study 33 (36.7%) subjects have been found to have hypertension along with POAG.

DIABETES MELLITUS (DM):

Several theories on relation of DM with POAG have shown that chronic hyperglycemia with dyslipidaemia may increase the risk of neuronal damage due to oxidative stress.[44] Similarly, various studies have demonstrated that diabetic eyes exhibit diminished retinal blood flow due to their poor ability to autoregulate blood flow. Ciccone et al have studied the impact of high sugar levels in pre-diabetic patients with a strong family history of DM. Various biochemical mechanisms and theories are thought to be activated leading to endothelial dysfunction followed by dysregulated vascular flow.[45] In our study 24

cases (26.7%) were found to have Diabetes Mellitus out of all the patients with POAG.

Cardiovascular disease has emerged as a highly significant risk factor for rapid progression. In our study 14 (15.6%) cases were found to have some cardiovascular diseases out of all the POAG patients. Patients with a cardiovascular history had double the chance to be rapid progressors as compared with controls.[46] Pillunat LE et al. hypothesized that generalized vascular disease may lead to NTG. He showed that there is lack of autoregulation in optic nerve head circulation only in normal tension glaucoma (NTG), whereas Anderson suggested defective autoregulation in POAG and NTG.[47]

INTRAOCULAR PRESSURE AND CUP:DISC RATIO :

It is a well established risk factor in the pathogenesis of glaucoma of POAG. The Ocular Hypertension Treatment Study shows that risk of developing POAG is up to six times higher in ocular hypertension than in those without any risk factors for glaucoma. The risk of developing POAG in ocular hypertension has been estimated to be 1–2% per year or about 10% per decade. Recent data from the OHTS indicates that this risk could be higher at 9.5% over five years. The risk of developing glaucoma in ocular hypertension is suggested to rise with IOP, with risk significantly increased for a baseline IOP of 24 mm Hg or greater, and especially for IOP over 30 mm Hg.[48] In our study, we found out a correlation between rise in IOP with increase in severity of POAG. The statistics in the study showed that, there was strong positive correlation between IOP and C:D ratio, which meant an increase in IOP showed an increase in C:D ratio. There was strong negative correlation between IOP and RNFL, showing a decrease in RNFL with an increase in IOP ($p = 0.000$).

RNFL THICKNESS ASSESSMENT ON OCT IN POAG :

Kaw et al. in their study aimed to compare SD-OCT evaluation of RNFL thickness in normal controls and POAG cases of various stages and found that normal patients had the thickest RNFL thickness when compared with patients and increased glaucoma severity was associated with thinner RNFL.[49] Kanamori et al. in their study of 160 normal eyes showed slightly higher values than those in our study.[50] They found that superior thickness (145.5± 19.6μ), was maximum followed by inferior RNFL thickness (143.1±19.5μ), temporal (98.7±20.8μ) and lastly in nasal quadrant (92.6±20.4μ). Their observation also did not follow the ISNT (Inferior, superior, nasal and temporal) rule. Bowd et al. (30 eyes) found lower values as compared to our study.[51] They noted a highest inferior (107.6μ) followed by superior (105.7μ) quadrant RNFL thickness; the temporal (66.2μ) quadrant had a higher thickness as compared to the nasal quadrant (61.8μ). These variations in the quadrantic RNFL thickness can again be attributed to various variations in the population studied.

In our study, the RNFL thickness in mild, moderate and severe POAG was studied. 76 eyes (42%) had mild glaucoma with a RNFL thickness of 75.1 to 80 microns, 78 eyes (43%) had moderate glaucoma with a RNFL thickness of 72.1 to 75 microns and 26 eyes (15%) had severe glaucoma with a RNFL thickness of 60 to 72 microns. In RNFL thinning quadrant-wise distribution in POAG cases of the study sample, 80 eyes (44%) showed thinning in the inferior quadrant, 63 eyes (35%) showed thinning in the superior quadrant, 29 eyes (16%) showed thinning in the nasal quadrant and 8 eyes (5%) showed thinning in the temporal quadrant.

In our study, screening of subjects was done for both eyes on Perimetry as well as OCT, and the interpretations of both the methods was noted for every patient, thereby categorizing the severity of the disease into mild, moderate and severe glaucoma. 10 normal patients were also included to look for false positive results and errors elicited by these methods. Perimetry showed sensitivity of 92.78% , specificity of 90% and area under ROC to be 0.942. In comparison to this, our OCT results showed a sensitivity of 97.22%, specificity of 95% and area under ROC to be 0.998. Our study found that RNFL thickness has a good diagnostic value for diagnosis of glaucoma and for staging glaucoma into mild, moderate and severe stages. This is in agreement with the study of Elbendary and Helal[52] that included prospective and retrospective cohort studies and case-control studies that evaluated the accuracy of OCT for diagnosing glaucoma. They reported that RNFL had a high accuracy for diagnosing glaucoma.

RESULTS :

Mean age of study sample was 55.03 years with standard deviation of 14.71 years, with the highest 80 years and lowest 20 years. There were 36 (40%) females and 54 (60%) males in the study.

Family history of glaucoma was present in 16 (18%) subjects, 59 (66%) subjects belonged to urban areas, while 31 (34%) belonged to rural regions among all the study subjects. 33 (36.7%) subjects were having hypertension followed by 24 (26.7%) with diabetes mellitus.

There was strong positive correlation between IOP with CD ratio, which indicated that a rise in IOP also showed a rise in CD ratio. There was a strong negative correlation between IOP with RNFL, which meant an increase in IOP corresponding to a decrease in RNFL. ($p = 0.000$)

On application of Anova test, mean of IOP in subjects with severe visual field defects on perimetry was higher than those with mild or moderate visual field defects and the difference was statistically highly significant ($p = 0.000$).

OCT showed higher sensitivity, specificity & area under curve in ROC than perimetry (97.22%, 95%, 0.998 vs. 92.78%, 90%, 0.942 respectively), which suggests that OCT is a more accurate diagnostic test for detection of glaucoma as compared to perimetry.

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CONCLUSION:

Intraocular pressure reduced the retinal nerve fiber (RNFL) thickness which was accurately & early picked up by the OCT than Perimetry, as it had higher sensitivity, specificity & area under curve in ROC. The technique of OCT is relatively quick and simple for detection of glaucoma. RNFL changes seen on OCT shows thinning most commonly in inferior quadrant, followed by superior, nasal and temporal quadrants. The quantitative measurements of RNFL thickness on OCT helps in assessing the severity of POAG.

OCT allows detection of localized & diffuse loss of RNFL and measurement of rate of change in RNFL thickness in patients with glaucoma. Measuring the rate of nerve fiber layer loss is important in discerning the course of disease progression, prediction of prognosis and evaluating response to treatment.

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