Original Articles

A Comparative Study of Macular Thickness in Primary open Angle Glaucoma Patients and Normal Patients.

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KEY WORDS : Macular thickness,Glaucoma,Optical coherence tomography

ABSTRACT

Aim : To compare difference of macular thickness using optical coherence tomography (OCT) in primary open angle glaucoma (POAG)patients and normal subjects..

Materials and methods :

This Observational case control study included primary open angle glaucoma(POAG) patients(n=60eyes)and healthy subjects in the control group(n=60eyes).All subjects underwent detailed history,general examination,and systemic examination. Complete ocular examination included best corrected visual acuity(BCVA),slit lamp examination, intraocular pressure(IOP),gonioscopy,dilated fundus biomicroscopy.visual fied analysis was done using haag streit octopus 900 machine.

Optical coherence tomography imaging machine was performed using Topcon 3D OCT machine, version 8.42003.01.In both these groups,parameters analysed were macular thickness and macular volume.

Results :

The POAG group had significantly decreased values of macular thickness(11.3%) macular thickness in POAG as compared to control (265.09 ± 12.60 vs. 235.16 ± 7.64, p<0.001). and macular volume (7.68 ± 0.46 vs. 7.00 ± 0.48, p<0.001).Thus ,macular thickness and macular volume parameters may be used for making the diagnosis of glaucoma, especially in patients with abnormalities of disc.

INTRODUCTION

Primary open angle glaucoma is a chronic , progressive optic neuropathy in adults in which there is a characteristic acquired atrophy of the optic nerve and loss of retinal ganglion cells and their axons [1]. Because 50% of the RGCs are located within the macula[2] and the macular shape is generally less variable than the ONH, macular thickness assessment has been considered for evaluating structural changes of glaucoma. High-resolution imaging of retinal structure is done through optical coherence tomography.

Zeimer et al [3] first suggested imaging of the macula as a potential location for glaucoma evaluation. Macular thickness measurements by optical coherence tomography (OCT) have been shown in previous studies to be significantly thinner in glaucomatous eyes compared to healthy eyes[4]

RETINA

Retina is a thin membrane extending from the optic disc to the ora serrata in front. It varies in thickness from 0.4mm near the optic nerve to 0.15mm anteriorly at the ora serrata.[5]

Macular thickness

The macula contains over 50% of all retinal ganglion cells and is an ideal area for detection of early cell loss and changes over the time because of high cell density.[5] In the macular area, ganglion cells are arranged in 4 to 6 layers making up 30 to 35% of retinal macular thickness, so that the loss of macular ganglion cells results in significant retinal or retinal nerve fiber layer thinning.

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OPTICAL COHERENCE TOMOGRAPHY

OCT uses low-coherence interferometry to produce a two-dimensional image of optical scattering from internal tissue microstructures in a way that is analogous to ultrasonic pulse-echo imaging..

The diagnosis and management of glaucoma are currently difficult clinical problems. Intraocular pressure measurements often do not adequately predict the progression of glaucoma. [6]

METHODOLOGY

Method of collection of data : Data was collected after approval from Institutional Review Board(IRB) ,government medical college.

Study Area : Department of Ophthalmology and Government Medical College.

Sample Size : 60 patients-30 patients of primary open angle glaucoma and 30 normal patients(control group).

Study period : Study was carried out over a period of 6 months.

Ethical consideration : Informed and written consent from each participant was taken.

Statistical analysis : Comparision between the values of macular thickness between primary open angle glaucoma patients and normal patients will be done .Independent Student's t test and chi-square ($\chi 2$) test were used for statistical analysis.

Inclusion criteria

- Patients age more than 30 years of either sex.
- Patients who will be ready for written and inform consent.
- A case of primary open angle glaucoma and normal subjects(control group).

Exclusion criteria

- Patients who are not ready to give written and inform consent.
- Patients with any other retinal disease.
- Patients with any other associated ocular disease or deformity that hampers posterior segment evaluation by oct like dense cataract,corneal opacity.
- Patients on steroid therapy and on any other medications known to affect retina.

MATERIAL

- The study was performed on patients diagnosed as primary open angle glaucoma and normal patients(control group).
- All patients underwent :

1. Visual assesment using Snellen's visual acuity chart.
2. Examination of anterior segment in detail using slit lamp biomicroscopy.
3. Refraction.
4. Intraocular pressure measurement using goldmann applanation tonomertry.
5. Gonioscopy using 3 mirror lens.
6. Perimetry by haag streit octopus 900 machine.
7. Dilated fundus examination was done using 90 D lens on slit lamp biomicroscope. The participant's both eyes were dilated using tropicamide (0.8%)+ phenylephrine (5%). Dilated fundus findings were noted which included media,disc ,macula,blood vessels and background.
8. All patients then underwent macular thickness evaluation using optical coherence tomography. OCT was done using TOPCON 3D OCT machine, version 8.42003.01.

OBSERVATION

DEMOGRAPHIC CHARACTERISTICS :

The demographic characteristics (age and sex) of two groups is summarised as summarised in Table I and also shown in Figure I and II, respectively. The age of control and POAG ranged from 34-77 yrs and 34-65 yrs respectively with mean (± SD) 50.93 ± 9.79 yrs and 52.53 ± 7.78 yrs respectively and median 49 yrs and 54 yrs respectively. The mean age of POAG group was slightly higher than control group. Comparing the mean age of two groups, Student's t test showed similar age between the two groups (50.93 ± 9.79 vs. 52.53 ± 7.78, t=0.70, p=0.486) i.e. did not differ significantly

Further, in control group, there were 14 (46.7%) females and 16 (53.3%) males whereas it were 15 (50.0%) and 15 (50.0%) in POAG group. Comparing the sex proportion (M/F) of two groups, $\chi 2$ test showed similar sex proportion between the two groups ($\chi 2$=0.07, p=0.796) i.e. also not differ significantly.

SECONDARY OUTCOME MEASURES

I. RIGHT EYE

The secondary outcome measures (Best corrected visual acuity , Slit lamp examination, Intraocular Pressure, MEDIA, CDR, MACULA, Blood vessels, Background, gonioscopy) of two groups at right eye is summarised in Table II and also shown in Fig.III-VII. Comparing the

Table I: Demographic characteristics (Mean ± SD) of two groups

Variable	Control(n=30) (%)	POAG (n=30) (%)	tχ^2 value	p value
Age (yrs)	50.93 ± 9.79	52.53 ± 7.78	0.70	0.486
Sex: Female	14 (46.7)	15 (50.0)	0.07	0.796
Male	16 (53.3)	15 (50.0)		

Age of two groups was compared by Student's t test whereas sex was compared by χ^2 test.

Table II : Secondary outcome measures (Mean ± SD) of two groups at right eye

Variable	Control(n=30) (%)	POAG (n=30) (%)	t/χ^2 value	p value
BCVA:				
5/60	0 (0.0)	3 (10.0)	30.64	<0.001
6/12	3 (10.0)	2 (6.7)		
6/18	5 (16.7)	5 (16.7)		
6/24	3 (10.0)	5 (16.7)		
6/36	1 (3.3)	7 (23.3)		
6/6	16 (53.3)	0 (0.0)		
6/60	1 (3.3)	8 (26.7)		
6/9	1 (3.3)	0 (0.0)		
SLE: WNL	30 (100.0)	30 (100.0)	NA	NA
IOP (mmHg)	13.73 ± 1.74	18.77 ± 1.89	10.74	<0.001
MEDIA : CLEAR	16 (53.3)	11 (36.7)	4.96	0.084
IMC	14 (46.7)	15 (50.0)		
PSPH	0 (0.0)	4 (13.3)		
CDR	0.37 ± 0.06	0.71 ± 0.08	18.01	<0.001
MACULA :				
DULL FR	5 (16.7)	7 (23.3)	0.42	0.519
FR+	25 (83.3)	23 (76.7)		
B/V: NORMAL	30 (100.0)	30 (100.0)	NA	NA
B/G: NORMAL	30 (100.0)	30 (100.0)	NA	NA
I/G: OPEN	30 (100.0)	30 (100.0)	NA	NA
ANGLE				

IOP and CDR of two groups were compared by Student's t test whereas .

BCVA, MEDIA, MACULA were compared by χ^2 test.

Fig. I. Mean age of two groups

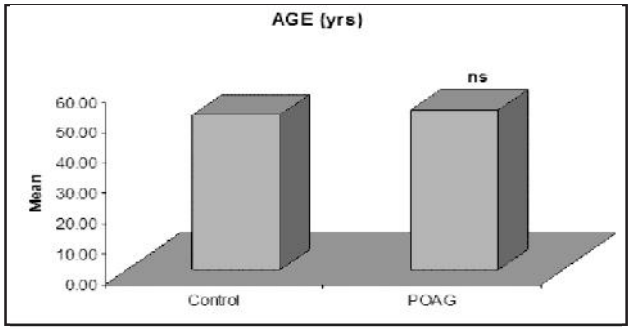


Fig. II. Distribution of sex ratio of two groups.

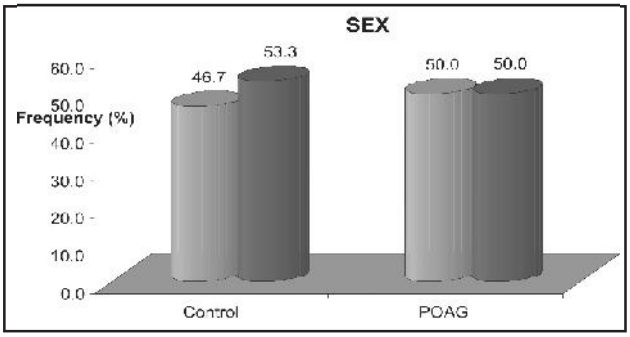


Fig. III. Distribution of BCVA of two groups at right eye.

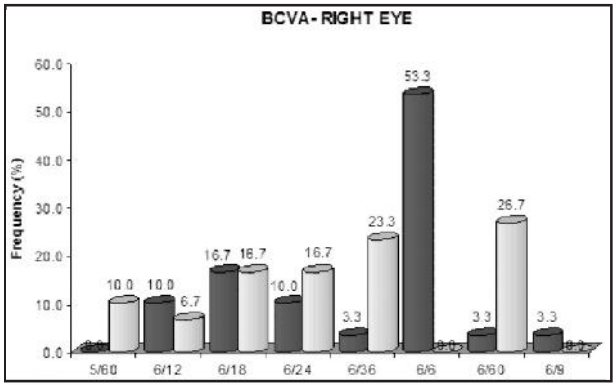


Fig. IV. Mean IOP of two groups at right eye

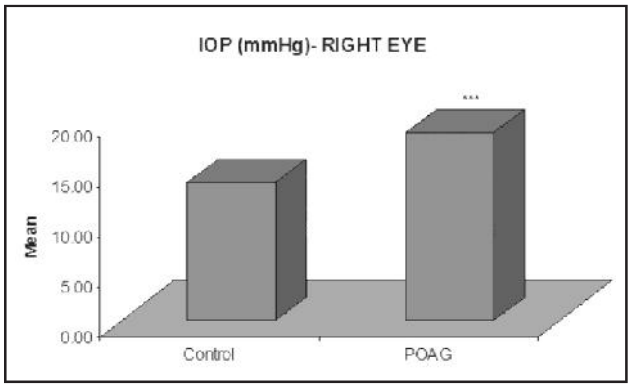


Fig.V. Distribution of media of two groups at right eye

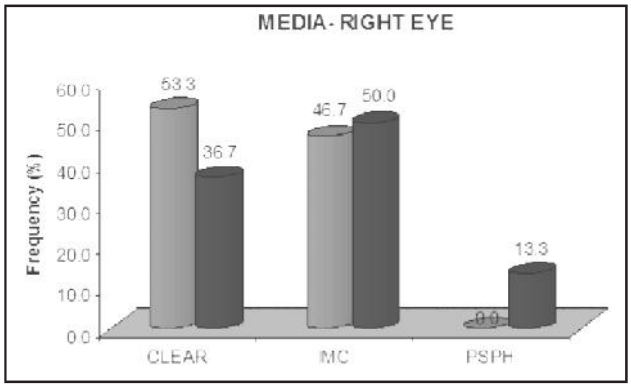


Fig. VI. Distribution of macula of two groups at right eye.

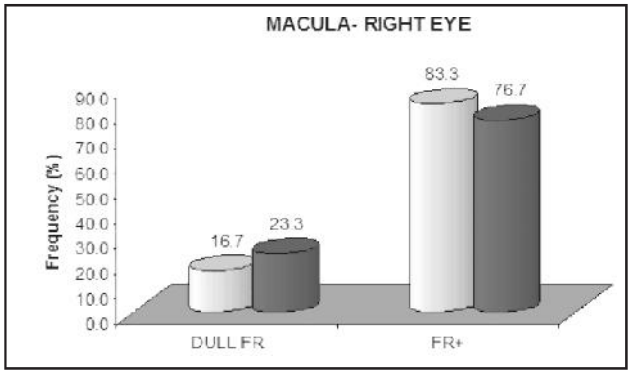


Fig. VII. Mean CDR of two groups at right eye

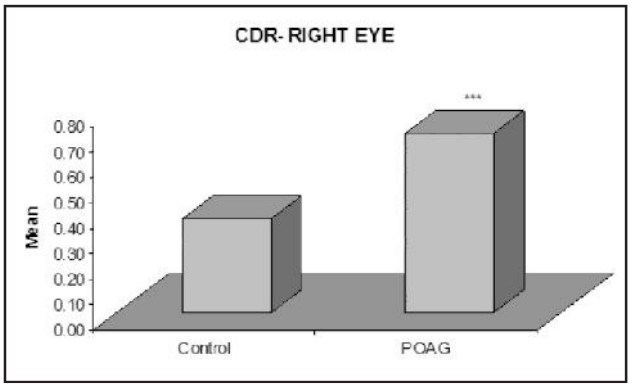


Fig. VIII:distribution of perimetry in right eye

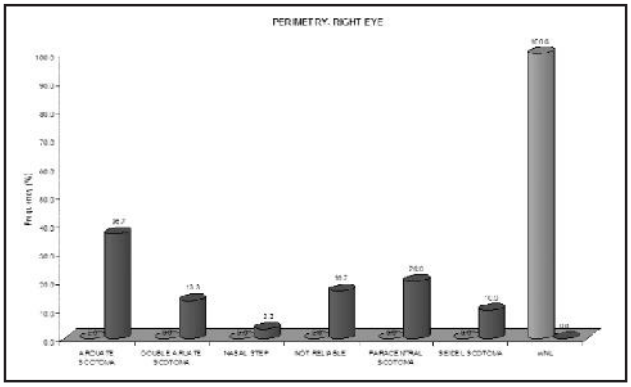


Fig. IX. Mean IOP of two groups at left eye.

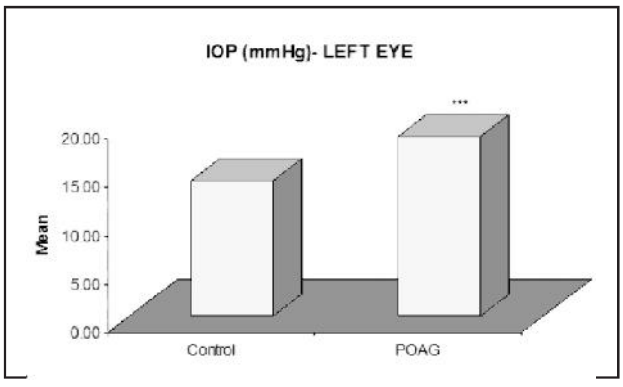


Fig. X. Distribution of media of two groups at left eye.

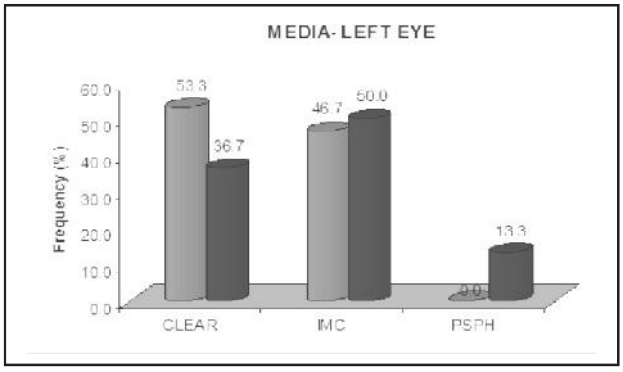


Table III: Distribution of perimetry of two groups at right eye

Perimetry	Control(n=30) (%)	POAG (n=30) (%)	χ^2 value	p value
ARCUATE	0 (0.0)	11 (36.7)	60.00	<0.001
SCOTOMA				
DOUBLE	0 (0.0)	4 (13.3)		
ARUATE SCOTOMA				
NASAL STEP	0 (0.0)	1 (3.3)		
NOT RELIABLE	0 (0.0)	5 (16.7)		
PARACENTRAL SCOTOMA	0 (0.0)	6 (20.0)		
SEIDEL SCOTOMA	0 (0.0)	3 (10.0)		
WNL	30 (100.0)	0 (0.0)		

Perimetry of two groups were compared by χ^2 test.

Fig. XI. Distribution of macula of two groups at left eye

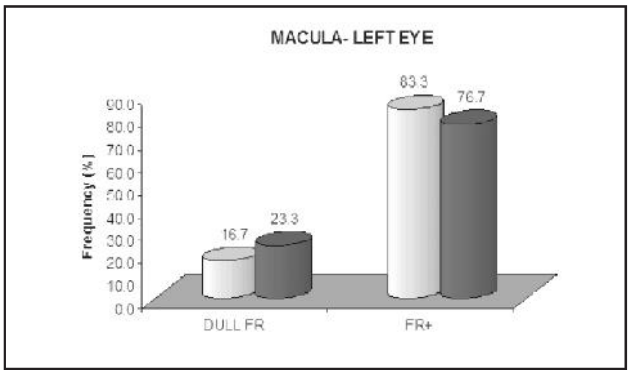


Fig. XII. Mean CDR of two groups at left eye.

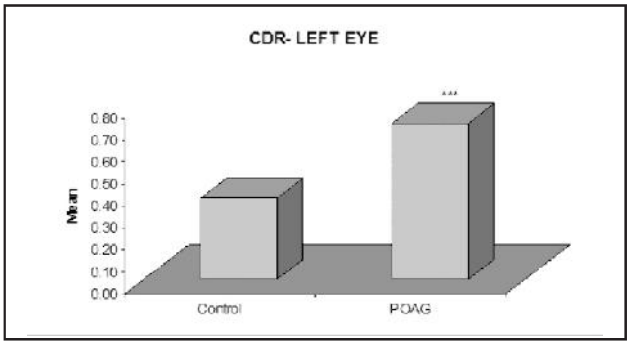


Fig. XIII. Distribution of perimetry of two groups at left eye

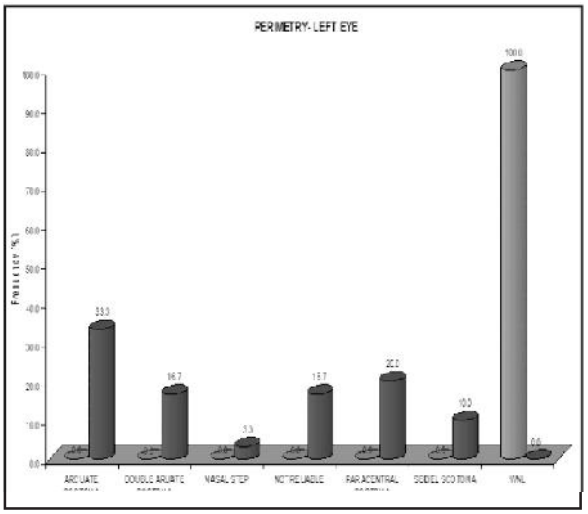


Fig. XIV. Mean macular thickness of two groups at right eye.

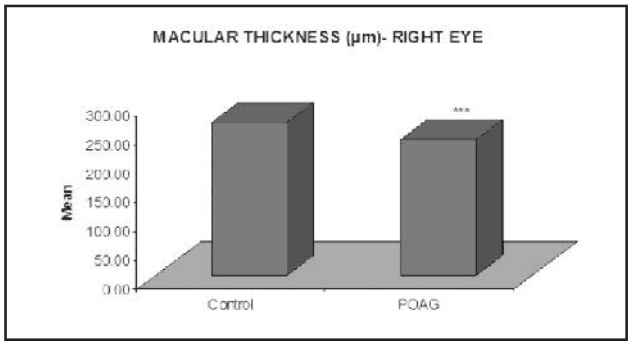


Table IV: Secondary outcome measures (Mean ± SD) of two groups at left eye

Variable	Control(n=30) (%)	POAG (n=30) (%)	t/χ^2 value	p value
BCVA:				
5/60	0 (0.0)	2 (6.7)	33.61	<0.001
6/12	3 (10.0)	2 (6.7)		
6/18	5 (16.7)	3 (10.0)		
6/24	3 (10.0)	4 (13.3)		
6/36	1 (3.3)	9 (30.0)		
6/6	16 (53.3)	0 (0.0)		
6/60	1 (3.3)	10 (33.3)		
6/9	1 (3.3)	0 (0.0)		
SLE: WNL	30 (100.0)	30 (100.0)	NA	NA
IOP (mmHg)	14.07 ± 1.51	18.60 ± 1.43	11.96	<0.001
MEDIA: CLEAR	16 (53.3)	11 (36.7)	4.96	0.084
IMC	14 (46.7)	15 (50.0)		
PSPH	0 (0.0)	4 (13.3)		
CDR	0.37 ± 0.06	0.71 ± 0.09	17.46	<0.001
MACULA:				
DULL FR	5 (16.7)	7 (23.3)	0.42	0.519
FR+	25 (83.3)	23 (76.7)		
B/V: NORMAL	30 (100.0)	30 (100.0)	NA	NA
B/G: NORMAL	30 (100.0)	30 (100.0)	NA	NA
I/G: OPEN ANGLE	30 (100.0)	30 (100.0)	NA	NA

IOP and CDR of two groups were compared by Student's t test whereas BCVA, MEDIA, MACULA were compared by χ^2 test.

Fig. XV. Mean macular thickness of two groups at left eye

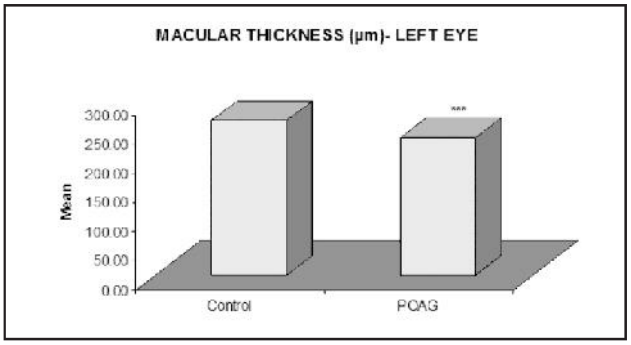


Fig. XVI. Mean macular volume of two groups at right eye.

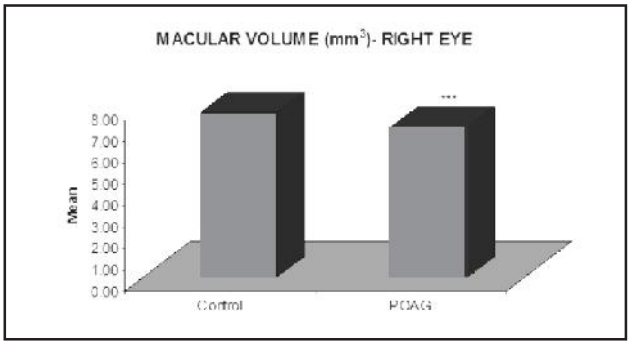


Table V: Distribution of perimetry of two groups at left eye

Perimetry	Control(n=30) (%)	POAG (n=30) (%)	t/χ^2 value	p value
ARCUATE SCOTOMA	0 (0.0)	10 (33.3)	60.00	<0.001
DOUBLE ARUATE	0 (0.0)	5 (16.7)		
SCOTOMA NASAL STEP	0 (0.0)	1 (3.3)		
NOT RELIABLE	0 (0.0)	5 (16.7)		
PARACENTRAL SCOTOMA	0 (0.0)	6 (20.0)		
SEIDEL SCOTOMA	0 (0.0)	3 (10.0)		
WNL	30 (100.0)	0 (0.0)		

Perimetry of two groups were compared by χ^2 test.

Table VI: Macular thickness (Mean ± SE) of two groups at right and left eye

Eye	Control(n=30)	POAG(n=30)	t value	p value
Right	265.09 ± 12.60	235.16 ± 7.64	11.13	<0.001
Left	266.60 ± 11.31	235.83 ± 7.77	12.28	<0.001

Macular thickness of two groups was compared by Student's t test

Table VII: Macular volume (Mean ± SE) of two groups at right and left eye

Eye	Control(n=30)	POAG(n=30)	t value	p value
Right	7.68 ± 0.46	7.00 ± 0.48	5.60	<0.001
Left	7.65 ± 0.42	7.03 ± 0.48	5.34	<0.001

Macular volume of two groups was compared by Student's t test.

Table VIII:Similar studies done showed an IOP&CDR distribution as:

Study	IOP	CDR
Our study	13.73 ± 1.74 vs. 18.77 ± 1.89	0.37 ± 0.06 vs. 0.71 ± 0.08
Anjali Sharma et al [11]	14.45 vs 23.33	0.38 vs 0.63
Haitham Y et al [8]	15.5±6.6 (10–34)	-

Table IX:Similar studies done showed an age distribution as:

Study	Total subjects with (POAG)	Mean age distribution
Our study	30	52.53 ± 7.78 yrs
David s et al[7]	30	56.7 ± 20.3 yrs
Haitham Y et al[8]	42	53.7 ± 3.7 years
Behzad FALLAHI MOTLAGH et al[9]	104	59.96 ± 8.75 years

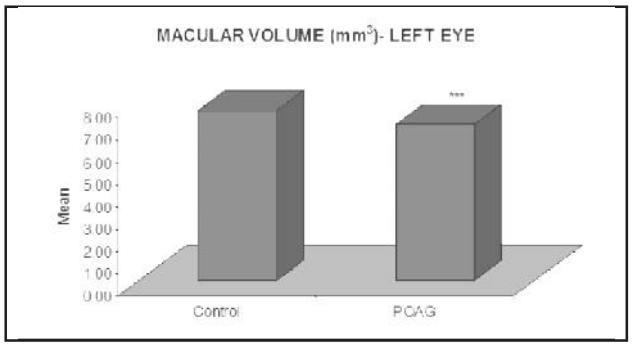
Table X:Similar studies done showed a Macular thickness distribution as

Study	Macular thickness
Our study	265.09 ± 12.60 vs. 235.16 ± 7.64
Anjali Sharma et al [11]	263.56 vs 243.96 mm
David s et al [7]	278+_24m vs 304+-15m
Behzad FALLAHI MOTLAGH et al [9]	276.96 ± 7.80 (262.00 to 298.00)

Table XI : Similar studies done showed a Macular volume distribution as

Study	Macular thickness
Our study	7.68 ± 0.46 vs. 7.00 ± 0.48
Anjali Sharma et al [11]	6.64 ± 0.17 vs 6.18 ± 0.39

Fig. XVII. Mean macular volume of two groups at left eye



quantitative IOP and CDR of two groups at right eye, Student's t test showed significantly different and higher IOP (26.8%) (13.73 ± 1.74 vs. 18.77 ± 1.89, t=10.74, p<0.001) and CDR (47.9%) (0.37 ± 0.06 vs. 0.71 ± 0.08, t=18.01, p<0.001) both in POAG patients as compared to control subjects

Further, comparing the distribution of PERIMETRY of two groups at right eye, χ2 test showed significantly different distribution of PERIMETRY (χ2=60.00, p<0.001) between the two groups (Table III and Fig. VII).

Similarly, comparing the distributions of categorical BCVA, MEDIA and MACULA of two groups at right eye, χ2 test showed significantly different distribution of BCVA (χ2=30.64, p<0.001) between the two groups while distributions of both MEDIA and MACULA were found similar (p>0.05) between the two groups i.e. did not differ significantly.

II. LEFT EYE

The secondary outcome measures (BCVA, SLE, IOP, MEDIA, CDR, MACULA, B/V, B/G and I/G) of two groups at left eye is summarised in Table IV and also shown in Fig IX-XII. Comparing the quantitative IOP and CDR of two groups at left eye, Student's t test showed significantly different and higher IOP (24.4%) (14.07 ± 1.51 vs. 18.60 ± 1.43, t=11.96, p<0.001) and CDR (47.9%) (0.37 ± 0.06 vs. 0.71 ± 0.09, t=17.46, p<0.001) both in POAG patients as compared to control subjects.

Similarly, comparing the distributions of categorical BCVA, MEDIA and MACULA of two groups at left eye, χ2 test showed significantly different distribution of BCVA (χ2=33.61, p<0.001) between the two groups while distributions of both MEDIA and MACULA were found

similar (p>0.05) between the two groups i.e. did not differ significantly.

Further, comparing the distribution of PERIMETRY of two groups at left eye, χ2 test showed significantly different distribution of PERIMETRY (χ2=60.00, p<0.001) between the two groups (table V, figure XIII).

PRIMARY OUTCOME MEASURES

I. MACULAR THICKNESS

The macular thickness of two groups at both right and left eye is summarised in Table VI and also depicted in Fig. XIV and XV, respectively. Comparing the macular thickness of two groups at right eye, Student's t test showed significantly different and lower (11.3%) macular thickness in POAG patients as compared to control subjects (265.09 ± 12.60 vs. 235.16 ± 7.64, mean difference=29.94, t=11.13, p<0.001) (Table VI and Fig.XIV).

Similarly, comparing the macular thickness of two groups at left eye, Student's t test showed significantly different and lower (11.5%) macular thickness in POAG patients as compared to control subjects (266.60 ± 11.31 vs. 235.83 ± 7.77, mean difference=30.77, t=12.28, p<0.001) (Table VI and Fig. XV)

II. MACULAR VOLUME

The macular volume of two groups at both right and left eye is summarised in Table VII and also shown in Fig.XVI and XVII , respectively. Comparing the macular volume of two groups at right eye, Student's t test showed significantly different and lower (8.8%) macular volume in POAG patients as compared to control subjects (7.68 ± 0.46 vs. 7.00 ± 0.48, mean difference=0.68, t=5.60, p<0.001) (Table VII and Fig. XVI).

Similarly, comparing the macular volume of two groups at left eye, Student's t test showed significantly different and lower (8.1%) macular volume in POAG patients as compared to control subjects (7.65 ± 0.42 vs. 7.03 ± 0.48, mean difference=0.42, t=5.34, p<0.001) (Table VII and Fig. XVI)

DISCUSSION

In our study we compare and correlate macular thickness in primary open angle glaucoma patients and normal subjects using optical coherence tomography.

A total of 60 patients enrolled in the study. Out of which 30 were diagnosed case of primary open angle glaucoma (POAG) and 30 age and sex matched normal subjects without glaucoma were recruited served as control.

In our study it was found the mean age of POAG group was slightly higher than control group. Comparing the mean age of control vs POAG (50.93 ± 9.79 vs. 52.53 ± 7.78, t=0.70, p=0.486)

In varies studies it has been noticed that there is a negative relationship between retinal thickness and age, total macular volume and RNFL thickness Eriksson u et al [10]

We compared the quantitative IOP and CDR of two groups at right eye, test showed significantly different and higher IOP (26.8%) (13.73 ± 1.74 vs. 18.77 ± 1.89, t=10.74, p<0.001) and CDR (47.9%) (0.37 ± 0.06 vs. 0.71 ± 0.08, t=18.01, p<0.001) both in POAG as compared to control. Similarly, comparing the two groups at right eye, χ2 test showed significantly different distribution of BCVA (χ2=30.64, p<0.001) between the two groups while distributions of both MEDIA and MACULA were found similar (p>0.05) between the two groups.

Further, χ2 test showed significantly different distribution of PERIMETRY (χ2=60.00, p<0.001) between the two groups.

We are comparing the quantitative IOP and CDR of two groups in left eye, test showed significantly different and higher IOP (24.4%) (14.07 ± 1.51 vs. 18.60 ± 1.43, t=11.96, p<0.001) and CDR (47.9%) (0.37 ± 0.06 vs. 0.71 ± 0.09, t=17.46, p<0.001) both in POAG as compared to control. Similarly, χ2 test showed significantly different distribution of BCVA (χ2=33.61, p<0.001) between the two groups while distributions of both MEDIA and MACULA were found similar (p>0.05) between the two groups.

Further, χ2 test showed significantly different distribution of PERIMETRY (χ2=60.00, p<0.001) between the two groups .

We compare the macular thickness of two groups in right eye, test showed significantly different and lower (11.3%) macular thickness in POAG as compared to control (265.09 ± 12.60 vs. 235.16 ± 7.64, mean difference=29.94, t=11.13, p<0.001). Similarly left eye, test showed significantly different and lower (11.5%) macular thickness in POAG as compared to control (266.60 ± 11.31 vs. 235.83 ± 7.77, mean difference=30.77, t=12.28, p<0.001)

Thus it was seen that macular thickness was decreased in glaucomatous patients as compared to normal subjects. These findings are in correlation with studies discussed above and published literature. [12], [13]

We compare the macular volume of two groups in right eye, test showed significantly different and lower (8.8%) macular volume in POAG as compared to control (7.68 ± 0.46 vs. 7.00 ± 0.48, mean difference=0.68, t=5.60, p<0.001). Similarly left eye, test showed significantly different and lower (8.1%) macular volume in POAG as compared to control (7.65 ± 0.42 vs. 7.03 ± 0.48, mean difference=0.42, t=5.34, p<0.001)

CONCLUSION

With the increasing literature regarding the role of macular imaging by optical coherence tomography (OCT) in glaucoma care,Spectral domain OCT (SD-OCT) has allowed for high resolution imaging of the total macula and macular segments. It proves that macular thickness and volume shows a significant correlation with the glaucomatous damage. It may be useful method of documenting early glaucoma and monitoring progression.

Thus, in our study we conclude that macular parameters, such as total macular volume & macular thickness was significantly lower in open angle glaucoma patients when compared with the normal subjects. Thus in addition to RNFL thickness to aid in the diagnosis of early glaucoma using OCT, in certain conditions, such as disc abnormalities or peripapillary atrophy, where RNFL parameters may be distorted macular parameters may be relied upon.

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