

Study of Clinical Evaluation of Glaucoma with Anterior Segment OCT (Optical Coherence Tomography) and Optic Nerve Head OCT (Optical Coherence Tomography)

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Abstract: *Glaucoma is an ocular disease which of chronic and progressive nature which leads to optic neuropathy caused due to certain group of optic conditions which can cause damage to the nerve and further lead to loss of vision. Increased intraocular pressure remains the most common cause of glaucoma. A gradual and sustained rise in the intraocular pressure can occur because of increased formation of aqueous humour, problem in the drainage of the aqueous humour or it can also happen due to increased episcleral venous pressure. OCT imaging technique enables noncontact, non - invasive imaging of the anterior eye along with features of human retina including fovea and optic disc. Though imaging up to 2 to 3 mm deep can be achieved in most tissues. This is similar to conventional biopsy and histology. Imaging depth of OCT is more than 10 to 100 times finer than the standard clinical ultrasound. OCT has been applied in vitro to image arterial pathology and can differentiate plaque morphology. Aim: To study the anterior segment OCT and optic nerve head OCT findings in glaucoma. Material and methods: The study was conducted at KRISHNA INSTITUTE OF MEDICAL SCIENCES ON 45 patients who inclusive fulfill the criteria's were chosen as study subjects. Patients suspected with Glaucoma coming to the OPD at Krishna Hospital, Karad were included in the study. All the patients underwent AS - OCT and RNFL under various modalities and data were collected. The collected data was compiled in Microsoft Excel 2010. Data was analyzed using SPSS (Statistical Programme for Social Sciences) software 21 version, OpenEpi Software Version 2.3. Results: There were 45 patients in my study who were included in it. Out of this, 67% (30) of the participants were men, and 33% (15) were women. The most affected age group was determined to be 61-70 years old with 36% incidence. It was discovered that the AOD and TISA declined linearly with increasing pupil size in 78.2% of instances. On assessment of the laterality, 33% were involved with the right side and 67% with the left side. Three patients exhibited trabecular iris angles less than 25 degrees on AS - OCT, while the other patients all had angles greater than 25 degrees. we found that most of the patients had CCT 500 m It was also found that 6 patients age group 20 - 40 years with IOP range from 22 - 30 mmhg had CCT above 550 m and corrected was found to be effective. . Of these 6 patients, all had CDR values more than 0.6, but NRR was healthy. A P value of 0.001 was reported for the macular thickness, which was 276.26 (223 - 346) Because there hasn't been much research on AS - OCT and RNFL in relation to glaucoma, this work will be highly helpful for future references. Conclusion: Combining both aspects of the anterior and posterior segment which helps in early diagnosis of glaucoma and patient can start on treatment, as well as keeping track on progress, OCT imaging technique allows noncontact, non - invasive imaging of the anterior eye along with features of the human retina including fovea and optic disc and gives quantitative analysis, requiring minimal skills and taking less time to operate.*

1. Introduction

Glaucoma is an ocular disease which of chronic and progressive nature which leads to optic neuropathy caused due to certain group of optic conditions which can cause damage to the nerve and further lead to loss of vision. Increased intraocular pressure remains the most common cause of glaucoma. A gradual and sustained rise in the intraocular pressure can occur because of increased formation of aqueous humour, problem in the drainage of the aqueous humour or it can also happen due to increased episcleral venous pressure.

Of the cause mentioned, increased formation of aqueous humour and increased episcleral venous pressure are the very rare causes of glaucoma whereas hampering of aqueous humour drainage is the common cause of glaucoma. This can happen due to increased impediment of the drainage of aqueous humour through the angle of anterior chamber or it may happen along with difficulty in aqueous circulation in the pupil.

OCT imaging technique enables noncontact, non - invasive imaging of the anterior eye along with features of human retina including fovea and optic disc. Though imaging up to 2 to 3 mm deep can be achieved in most tissues. This is similar to conventional biopsy and histology. Imaging depth

of OCT is more than 10 to 100 times finer than the standard clinical ultrasound. OCT has been applied in vitro to image arterial pathology and can differentiate plaque morphology. AS OCT is a non - contact rapid imaging device which uses low coherence interferometry to obtain cross sectional image of anterior segment. Also AS OCT imaging allows for visualisation and assessment of anterior segment ocular features such as tear film, cornea, conjunctive, sclera, rectus muscles, anterior chamber angle structure and lens. The RNFL analysis used an automated OCT software algorithm to identify anterior and posterior margins of RNFL and average the measurements around the circular scan to obtain the average RNFL thickness globally for four quadrants (superior, nasal, inferior, and temporal)

Aim: To study the anterior segment OCT and optic nerve head OCT findings in glaucoma.

2. Material and Methods

The study was conducted at KRISHNA INSTITUTE OF MEDICAL SCIENCES ON 45 patients who inclusive fulfill the criteria's were chosen as study subjects. Patients suspected with Glaucoma coming to the OPD at Krishna Hospital, Karad were included in the study. All the patients underwent AS - OCT and RNFL under various modalities and data were collected. Thorough history and general examination

Past History, Ocular examination, Visual acuity, Slit Lamp, Anterior segment, fundus examination by indirect, Gonioscopy, Schiotz tonometer, Non - Contact Tonometer (NCT), applanation tonometer, OCT is Non - invasive non - contact diagnostic method that uses infrared light to analyse anterior segment or the retina. For example Macular oedema in DMO seen as hyporeflexive spaces within the retina, macular thickening and loss of foveal depression.

Inclusion criteria

All patients suspected with Glaucoma coming to the OPD at Krishna Hospital, Karad basis were included in the study.

Exclusion criteria

- All patients where fundus examination is difficult like patients with cataract, central corneal opacities
- Patients with old ocular trauma
- Unconscious and comatose patients
- Patients not willing to participate in the study
- Patients with other retinal manifestations eg ARMD, hypertensive retinopathy, diabetic retinopathy

3. Results

There were 45 patients in my study who were included in it. Out of this, 67% (30) of the participants were men, and 33% (15) were women. The most affected age group was determined to be 61–70 years old with 36% incidence. It was discovered that the AOD and TISA declined linearly with increasing pupil size in 78.2% of instances. On assessment of the laterality, 33% were involved with the right side and 67% with the left side. Three patients exhibited trabecular iris angles less than 25 degrees on AS - OCT, while the other patients all had angles greater than 25 degrees. With a $k = 0.4$, the correlation between the detection of a closed ACA quadrant by gonioscopy and ASOCT was passable. The calculation of central corneal thickness is also found to be very useful with correlation with the IOP patient with borderline raised IOP and in older patients we found that most of the patients had CCT 500 μ m. It was also found that 6 patients age group 20 - 40 years with IOP range from 22 - 30 mmHg had CCT above 550 μ m and corrected was found to be effective. However, ASOCT tended to detect more closed angles than gonioscopy, particularly in the superior and inferior. We discovered that the RNFL thickness declined significantly with ageing when we compared RNFL thickness between normal young & normal old ($p=0.0067$), and ($p=0.0045$) with glaucomatous eye. Of these 6 patients, all had CDR values more than 0.6, but NRR was healthy. A P value of 0.001 was reported for the macular thickness, which was 276 \pm 26 (223 - 346) μ m. Because there hasn't been much research on AS - OCT and RNFL in relation to glaucoma, this work will be highly helpful for future references.

Table 1: Distribution of ocular biometric data

IOP (median, IQR)	14.82 (17 - 18.5)
AL, mm	22.0 (1.26)
ACD, mm	2.8 (0.33)
LT, mm	4.6 (0.34)
CCT, μ m	536 (26.6)
SE, D	43.6 (1.6)
WTW, mm	11.4 (0.43)
LP	5.4 (0.28)
RLP	0.23 (0.0013)

AL Axial length, ACD Anterior chamber depth, LT Lens thickness, CCT Central corneal thickness, SE Spherical equivalent, WTW White to white – horizontal corneal diameter, SEM Standard error of mean. AL, ACD, LT, SE and WTW were similar among the groups

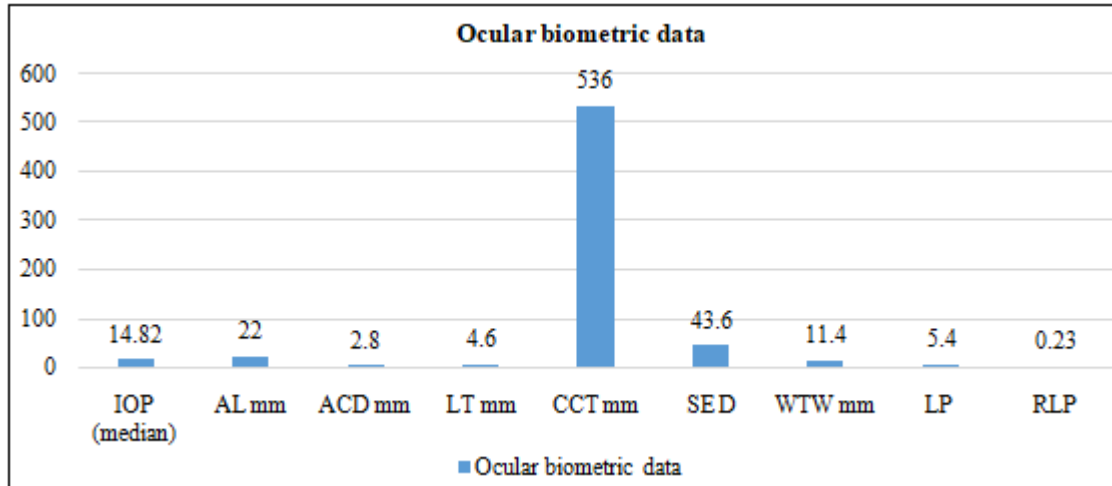


Chart 1: Bar chart describing the ocular biometric data

Table 2: Distribution of anterior chamber measurements:

Mean (SD) μm	OAG
AOD500 nasal	0.36 (0.16)
AOD500 temporal	0.38 (0.14)
TISA 500 nasal	0.16 (0.06)
TISA 500 temporal	0.14 (0.04)
TISA 750 nasal	0.24 (0.14)
TISA750 temporal	0.24 (0.12)

AOD500 Anterior angle opening distance at 500 μm from scleral spur. TISA500 and TISA750 Trabecular iris space area at 500 μm and 750 μm from scleral spur respectively. AOD500, TISA500 and TISA750 were similar nasally and temporally among groups.

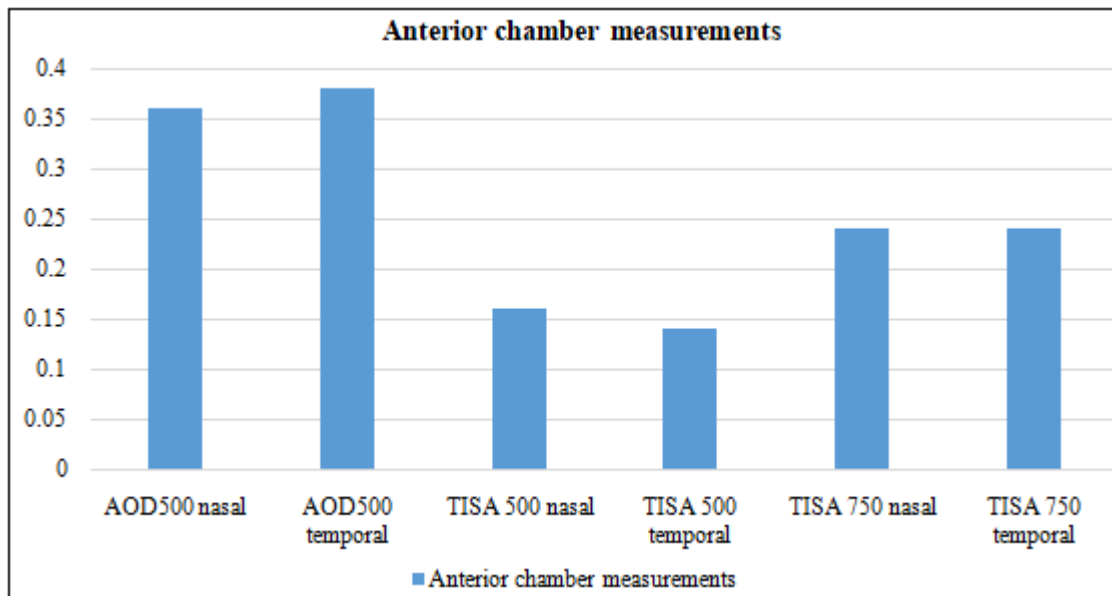


Chart 2: Bar chart showing the anterior chamber measurements

Table 3: Angle measure on AS OCT

Range (in degree)	0 - 15	16 - 30	31 - 45	>45
Trabecular iris angle	2	18	21	4
%	4.4%	40%	46.67%	8.8%

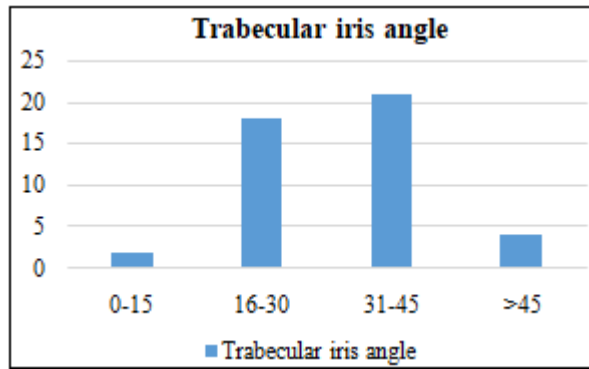


Chart 3: Bar chart showing the angle measurement on AS OCT

Table 4: Central corneal thickness measured on AS OCT

Range (µm)	400 - 450	451 - 500	501 - 550	551 - 600	601 - 650	>650
Central Corneal Thickness	4	10	19	9	2	1
%	8.8%	22.22%	42.22%	20%	4.4%	2.2%

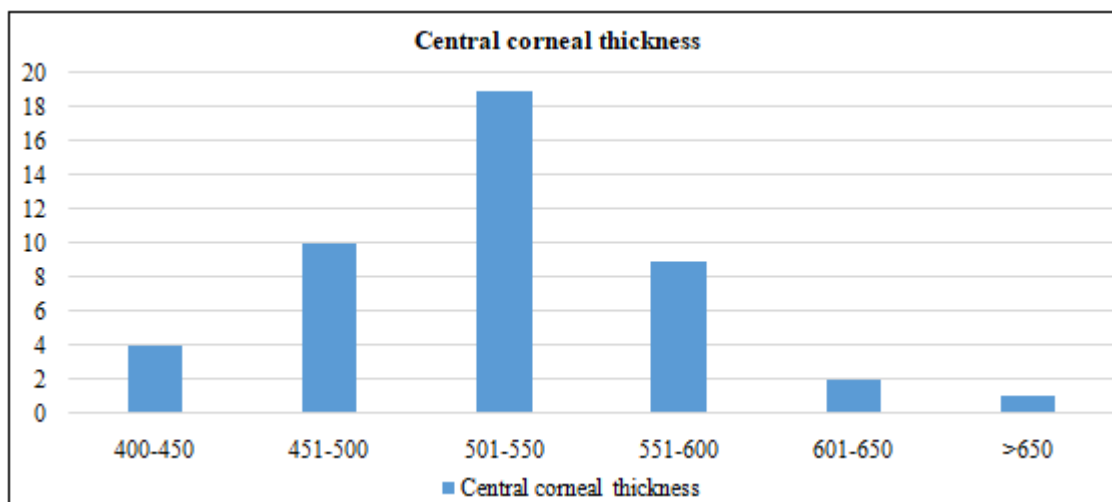


Chart 4: Bar diagram showing the distribution of central corneal thickness

Table 5: Average Retinal nerve fibre thickness

Total thickness	92 ± 5.5
Superior	110 ± 6.4
Inferior	112 ± 4.5
Temporal	65 ± 5.2
Nasal	70 ± 3.5

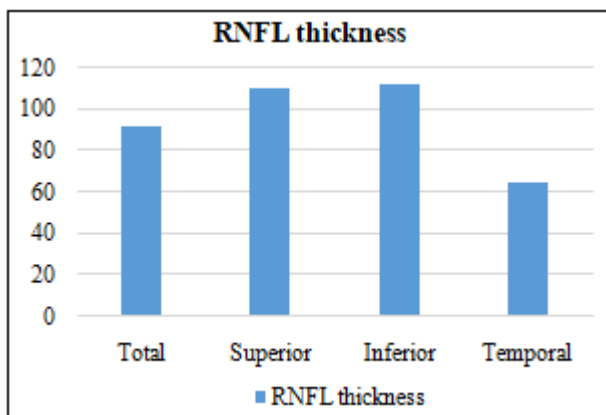


Chart 5: Bar showing the mean RNFL thickness among the study population

4. Discussion

Optic neuropathy, often known as glaucoma, is characterised by an acquired loss of retinal ganglion cells and axons within the optic nerve, which causes a distinctive appearance of the optic nerve head and a corresponding progressive loss of vision. This pattern of peripheral vision loss may also serve as a marker for other types of vision loss. Patients with POAG are typically asymptomatic until severe optic nerve damage if early glaucoma symptoms are not identified during a routine eye exam. Acute angle closure glaucoma typically manifests rapidly and can cause faster vision loss along with symptoms such as corneal oedema, eye pain, headache, nausea, and emesis. Although glaucoma cannot currently be prevented or cured, it can currently be managed to assist stop additional vision loss. This can be done with medications, glaucoma laser therapy, or incisional glaucoma procedures. Most of the patients in my study (36%) are between the ages of 61 and 70, while only 4% are between the ages of 21 and 30. There were 45 patients in total that were enrolled in the trial. Out of this, 67% (30) of the participants were men, and 33% (15) were women. Patients were also evaluated based on the affected eye, and it was discovered that 67% of patients in the research group had glaucoma in their right eye while 33% had it in their left. The intra ocular pressure and vision were both evaluated

during the optical examination. Out of a total of 45 patients, 40 had reasonably normal eyesight that improved after correction. Additionally, 5 individuals' vision did not improve at all. When patients first entered the ophthalmology department, 20 patients (44.44%) had normal 6/6 vision at the time of examination, 18 patients (40%) had 6/12 vision, 4 patients (8.9%) displayed 6/18 vision, one patient had 6/36 vision, and 2 patients (4.4%) had vision of fc or less than 3 meters. At the time of the patients' visit to the ophthalmology department, their intraocular pressure was also measured. The bulk of the patients, 24, had intraocular pressure between 22 and 30 mm Hg, while 18 patients were found to have intraocular pressure less than 21 mm Hg. In the study population, there were only 3 patients with intraocular pressure more than 30 mm Hg. The disc and rim region were examined optically as well. The study population's mean ratio was calculated to be 0.52 (with a standard deviation of 0.08). To account for any comorbidities present in the study population, a thorough history of the patients was also obtained. Six patients (13.33%) in total had a history of diabetes mellitus, and four (8.89%) had a history of hypertension. Comparatively, 5 patients (11.11%) of the study population were found to have both hypertension and diabetes mellitus. The presence of any family history of glaucoma was also evaluated in the patients, and it was discovered that 5 patients (11.11%) did. Twenty individuals in total (44.44%) had a comorbidity that was present in the research population. Gonioscopy is currently the gold standard for measuring anterior chamber angles (ACAs), but it has limitations, such as subjective and semiquantitative results, a need for light, reliance on the operator, and inability to distinguish between different angles when the gonioscope is in direct contact with the cornea. It was discovered that the AOD and TISA decreased linearly with increasing pupil size in 78.2% of instances; AS - OCT has the ability to provide useful quantitative and spatial information regarding dynamic changes of the angle configuration that normal gonioscopy and UBM cannot. It was determined that the AOD and TISA decreased linearly with increasing pupil size in the majority of cases (85.5% in AOD and 90.9% in TISA), and that for each mm change in pupil size, there was an average of 94 m change in the AOD 500 and 0.035 mm² change in the TISA. Leung et al. also described the dynamic ACA changes induced by dark - light changes. Three patients exhibited trabecular iris angles less than 25 degrees on AS - OCT, while the other patients all had angles greater than 25 degrees. Patients who participated in the study had their central corneal thickness measured. The research population's corneal thickness ranged from 400 micrometres to more than 650 micrometres. A total of 19 patients (42.22%) had central corneal thickness between 501 - 550 m, 9 patients (20%) had corneal thickness between 550 - 600 m, and only one patient (2.2%) had corneal thickness >650 m. Four patients (8.8%) had central corneal thickness between 400 - 450 m, ten patients (22.22%) had corneal thickness between 451 - 500 m, and the maximum number of patients. With a $k = 0.4$, the correlation between the detection of a closed ACA quadrant by gonioscopy and ASOCT was passable. However, gonioscopy did not always detect as many closed angles as ASOCT did, especially in the superior and inferior quadrants. Sakata et al. discovered that the intraobserver agreement in identifying the scleral spur (132 quadrants) on the same Visante OCT images was

moderate to substantial with $k = 0.65$. The location of the scleral spur on the ASOCT images was less discernible in the superior and inferior quadrants compared to the nasal and temporal quadrants (64, 67, 75, and 80%, respectively; $p = 0.001$) and in quadrants with a closed angle on gonioscopy (odds ratio = 0.54, $p = 0.02$). OCT is a brand - new optical imaging technique that uses backscattered or back - reflected light to perform high - resolution cross - sectional tomographic imaging of interior microstructure in biological systems. OCT images are typically two - dimensional data sets that depict the optical backscattering in a tissue's cross - section. Calculating central corneal thickness has also been proven to be quite helpful in individuals with borderline elevated IOP and older patients, the majority of whom had CCT values under 500 m. Six individuals with an age range of 20 to 40 years and an IOP range of 22 to 30 mm Hg were likewise discovered to have CCTs above 550 m, and their corrected reading was discovered to be lower than their actual reading in accordance with IOP adjustment charts. All six of these patients had CDRs more than 0.6, but their NRRs were all normal. To identify the front and posterior boundaries of the RNFL and to average the measurements made around the circular scan in order to determine the average RNFL thickness globally for four quadrants, the RNFL analysis used an automated OCT software programme (superior, nasal, inferior, and temporal). According to my research, the inferior quadrant of the eye has the thickest retina and the temporal quadrant has the thinnest. The study population's average RNFL thickness was 925.5. The RNFL thickness was 1106.4 in the superior quadrant, 1124.5 in the inferior quadrant, and 655.2 and 703.5, respectively, in the temporal and nasal quadrants, which were both comparatively less thick. Age - related reductions in RNFL thickness have been observed in cross - sectional studies of RNFL thickness utilising Spectral - Domain - OCT (Bendschneider D et al 2010 & Budenz DL 2008). The study shows that in normal aged eyes, the mean RNFL is thinner than in normal young eyes. When we evaluated the RNFL thickness between normal young & normal old ($p=0.0067$), and ($p=0.0045$) with glaucomatous eye, we discovered that the RNFL thickness dropped dramatically with advancing age. Rajul Parikh et al study. 's 32, which evaluated patients who were thought to be in the early stages of glaucoma and further divided them into normal people and early glaucoma patients for comparison, revealed that the RNFL changes in the early glaucoma patients. The study found that optical computed tomography has potential and may be utilised for patient screening because it showed relatively modest sensitivity and better specificity in diagnosing early glaucoma cases.

5. Conclusion

Combining both aspects of the anterior and posterior segment which helps in early diagnosis of glaucoma and patient can start on treatment, as well as keeping track on progress, OCT imaging technique allows noncontact, non - invasive imaging of the anterior eye along with features of the human retina including fovea and optic disc and gives quantitative analysis, requiring minimal skills and taking less time to operate. In our investigation, it was discovered that the majority of patients had open - angle glaucoma, with only three having creeping angle closure glaucoma. Because

there hasn't been much research on AS - OCT and RNFL in relation to glaucoma, this work is particularly helpful.

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