



Original Research Article

Evaluation of glaucoma cases with gonioscopy and optical coherence tomography

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ABSTRACT

Context: Glaucoma is the second leading cause of blindness in the adult population of India. Diagnosis and management depends on categorization of Glaucoma into open or closed angle.

Aims: To compare the accuracy of Gonioscopy and Anterior Segment Optical Coherence Tomography (ASOCT) in studying the structures of anterior chamber angle of the eye and find out the agreement between them in detecting angle closure.

Settings and Design: Cross-sectional observational study.

Materials and Methods: The present study is a hospital based cross-sectional study of patients between 20 to 80 years of age with Glaucoma attending the outdoor patient department in a tertiary care government hospital (New civil hospital), Surat. Patients having Corneal Opacity, and anti-Glaucoma surgeries done were excluded. All diagnosed cases of Glaucoma were evaluated by Gonioscopy in the dark with a Goldman 3 mirror lens Gonioscope at high (16x) magnification for static assessment (without indentation). A narrow slit beam, 2mm* 1mm, was cast during Gonioscopy, avoiding direct illumination over the pupil. The angle in each quadrant was graded with the Shaffer grading system. Anterior Segment OCT was done by TOPCON 3D OCT-1 MAESTRO machine. Imaging was performed in dark room conditions. Patients were imaged gazing straight ahead. Imaging of a single meridional section of the Anterior Chamber Angle at superior, inferior, temporal and nasal quadrants were performed. Grading of Anterior Chamber Angles on AS-OCT is termed as Closed if there is no visualization of Scleral Spur and/or any degree of irido-trabecular contact.

Statistical Analysis: kappa value, sensitivity & specificity, positive & negative likelihood ratio.

Results: Total 50 Glaucoma patients were examined by Gonioscopy and AS OCT. Total number of Angles examined were 400. Total number of Angles closed on Gonioscopy were 136 (34%). Total number of Angles closed on AS OCT were 190 (47.5%).

Conclusion: Agreement between Gonioscopy and AS OCT in detecting angle closure in all 4 quadrants was 'Moderate to Good' by Kappa Value.

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1. Introduction

Glaucoma is a neurodegenerative disease of the optic nerve that presents to the practitioner at various stages of a continuum characterized by accelerated ganglion cell death, subsequent axonal loss, optic nerve damage and eventual visual field loss and blindness.¹ It is one of the leading causes of blindness worldwide. Glaucoma is the second leading cause of blindness in adult population in India.^{2,3}

The incidence of POAG in India is 6.48 million, which is more than that of PACG which is 2.54 million.⁴ As the majority of Indian population is less than 30 years of age, the incidence of Glaucoma is expected to increase in the future. Thus, improving the detection rate is important to decrease the future burden of the disease and improve the quality of life of people suffering from the Glaucoma. According to National Programme for Control of Blindness (NPCB), Glaucoma is the third leading cause of blindness in India (5.80%) after cataract (62.6%) and refractive error (19.70%).⁵

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In the present times where extensive research is being done on Glaucoma, the definition of Glaucoma has changed over times. More and more classifications of Glaucoma are being given. Some etiologies may fall in more than one category now. With the advancement, we now have better ways of diagnosing and managing Glaucoma both medically and surgically. And to classify Glaucoma whether it is open angle or closed angle, traditionally Gonioscopy was the preferred method but now as advanced technologies are emerging, one of them is OCT which is Optical Coherence Tomography. OCT is an important, non-invasive imaging modality by which anterior as well as posterior segment of the eye can be examined. It captures micron resolution three-dimensional images. It is based on the principle of optical reflectometry, which involves the measurement of light back-scattering through transparent or semi-transparent media such as biological tissues. Anterior Segment OCT (ASOCT) is used for examination of the anterior chamber angle of the eye and also corneal thickness and corneal layers.

In present study, we have studied the diagnosed cases of Glaucoma for the assessment of the angle of the eye with use of Gonioscopy as well as ASOCT. The results of the study guide us about which one among Gonioscopy and OCT is the better modality for evaluation of the angle structures. The results of our study should be extrapolated to perform large population based study.

2. Materials and Methods

The present study is a hospital based cross-sectional study of patients with Glaucoma attending the outdoor patient department in a tertiary care government hospital (New civil hospital), Surat. All diagnosed patients of Glaucoma visiting OPD with age in between 20-80 years were examined, while patients having Corneal Opacity, having anti-Glaucoma surgeries done were excluded. Anterior chamber angle examination was done by Gonioscopy and Anterior Segment OCT. Gonioscopy was performed in the dark with a Goldman 3 mirror lens Gonioscope at high (16x) magnification for static assessment (without indentation). Anterior Segment OCT was done by TOPCON 3D OCT-1 MAESTRO machine. Imaging was performed in dark room conditions. Patients were imaged gazing straight ahead. Imaging of a single meridional section of the Anterior Chamber Angle at superior, inferior, temporal and nasal quadrants were performed. The angle in each quadrant by Gonioscopy was graded with the Shaffer grading system. Grading of Anterior Chamber Angles on AS-OCT is termed as Closed if there is no visualization of Scleral Spur and/or any degree of irido-trabecular contact.

3. Results and Discussion

The kappa statistic for the Table 1 - is 0.695 showing 'Moderate to Good' agreement between Gonioscopy and AS OCT in diagnosing closed angle in all 4 quadrant angles.

Total number of 50 Glaucoma patients were examined by Gonioscopy and AS OCT. Out of 50 patients of Glaucoma ratio of POAG: PACG was 1.94: 1. Male to female ratio was 1.17: 1. The majority of patients were in the age group of 45 to 55 years. Mean age of the study participants was 52.4 years. Total 400 Angles were examined. Total number of Angles closed on Gonioscopy were 136 (34%). Total number of Angles closed on AS OCT were 190 (47.5%).

T.A.TUN et al⁶ in their study concluded that the kappa agreement between AS OCT and Gonioscopy in detecting angle closure for Superior, Inferior, temporal and nasal quadrant was as follows: based on k value 0.59, 0.4, 0.28 and 0.48 respectively with Vertical and Horizontal quadrant value being 0.52 and 0.39 respectively which was Moderate.

In the current study, from Table 2 we can conclude that the kappa agreement between AS OCT and Gonioscopy in detecting angle closure for Superior, Inferior, Temporal and Nasal quadrant is 0.56, 0.58, 0.79 and 0.87 respectively with Vertical and Horizontal quadrant showing k value of 0.57 and 0.82 respectively. The agreement in Superior and Inferior quadrants is comparable in both the studies. However, the agreement in Temporal quadrant in our study was good while it was fair in the previous study. Similarly, the agreement in the nasal quadrant was strong in our study while it was moderate in the previous study. The difference can be explained by the fact that we have performed AS-OCT using TOPCON 3D MAESTRO 1 machine while Tun T.A. et al performed it using Cirrus HD OCT machine, also the study population in our study was different with respect to the age etc. in comparison to that of the previous study.

Conclusion from the Table 3 is AS OCT detected more number of eyes with Angle Closure of 1 or more quadrants than Gonioscopy.

3.1. Nolan et al⁷ studied 342 eyes of 200 patients with Gonioscopy and AS-OCT

In their study, AS OCT detected 71% of eyes with Angle Closure of 1 or more quadrants and Gonioscopy found 49.5%, which shows AS OCT detected more number of eyes with 1 or more Angle quadrant closed.

3.2. Sakata LM, Lavanya R, Friedman DS et al⁸ studied the findings of Gonioscopy and compared with the AS-OCT

In their study, AS OCT detected 59% of eyes with Angle Closure of 1 or more quadrants and Gonioscopy found 33%, which shows AS OCT detected more number of eyes with 1 or more Angle quadrant closed.

Table 1: Agreement between Gonioscopy and AS-OCT in detecting Angle Closure in all 4 quadrant angle

Gonioscopy	AS – Oct		Total	Kappa (SE)	95% CI
	Closed	Open			
Closed	133	3	136	0.695 (0.035)	0.627 to 0.764
Open	57	207	264		
			400		

Table 2: Agreement between gonioscopy and AS-OCT in quadrant wise closure

Agreement between AS OCT and Gonioscopy Quadrant wise closure	Kappa (95% CI)
Superior	0.56 (0.41-0.70)
Inferior	0.58 (0.43 – 0.73)
Temporal	0.79 (0.66-0.91)
Nasal	0.87 (0.77-0.97)
Vertical (superior + inferior)	0.572 (0.46-0.67)
Horizontal (nasal + temporal)	0.829 (0.75-.90)

Table 3: Angle closure agreements in 1 or more quadrants between Gonioscopy and AS OCT

Angle Closed in 1 or more Quadrants by	No. of Eyes (n= 100)	Percentage of Eyes
Gonioscopy	38	38%
AS-OCT	75	75%

Table 4: Comparison of Gonioscopy and OCT with respect to Sensitivity and Specificity for various definitions of closed Angle. (n= 50)

Definition of closure	Sensitivity (95% CI)	Specificity (95% CI)	Positive LR (95% CI)	Negative LR (95% CI)
≥1 quadrants closed	95.24 (76.18%-99.88.%)	27.59% (12.73% -47.24)	1.32 (1.03 – 1.68)	0.17 (0.02 – 1.28)
≥2 quadrants closed	100% (84.49% - 100%)	51.52% (33.54%-69.20%)	2.06 (1.45 –2.93)	0.00
≥3 quadrants closed	100% (80.49% - 100%)	78.79% (61.09%-91.02%)	4.71 (2.44 – 9.10)	0.00

Using the definition of 1 or more closed quadrants for closed angle (Table 4), the Sensitivity and Specificity of OCT were 95.24% and 27.59% respectively. Changing the definition to 2 or more closed quadrants, the sensitivity and Specificity increased to 100% and 51.52% respectively. The positive likelihood ratio also increased from 1.32 to 2.06 for the same. That difference remains same from changing definition from 2 to 3 or more angle quadrants closed. Thus, changing the definition to increase the number of closed quadrants increased the Sensitivity, Specificity and Positive LR of OCT.

In their study Tin A Tun et al,⁹ found that using the definition of 1 or more closed quadrants for closed angle, the Sensitivity and Specificity of OCT were 68.6% and 87.74% respectively. Changing the definition to 2 or more closed quadrants, the sensitivity and Specificity increased to 83.33% and 77.78% respectively. The positive likelihood ratio also increased from 5.59 to 3.75 for the same. Thus, changing the definition to increase the number of closed quadrants increased the Sensitivity, Specificity and Positive LR of OCT, which is comparable to the current study results. In both studies changing the definition to increase

the number of closed quadrants increased the Sensitivity, Specificity and Positive LR of OCT. The sensitivity of OCT in detecting closed angle in our study was higher in comparison to previous study. However, the specificity calculated in our study was lower in comparison to the previous study. We already know that there is a trade-off between sensitivity and specificity so that whenever sensitivity increases specificity decreases.

3.3. Sakata LM, Lavanya R et al.⁸ compared Gonioscopy with AS OCT and concluded

Angle closure on Gonioscopy and OCT respectively in Superior quadrant was 29% & 48%, inferior 22% & 43%, nasal 14% & 18%, temporal 20% & 12%.

Greater percentage of closed angles was diagnosed by Gonioscopy and AS OCT in the Superior & Inferior quadrants in the current study (Table 5), the study of Sakata LM, Lavanya R et al. also reported greater percentage of closed angles in the Superior and Inferior quadrant by Gonioscopy and AS OCT.

Table 5: Angle closure agreements in all 4 quadrants between Gonioscopy and ASOCT

Angle Closure in Quadrants	Gonioscopy	AS- OCT
Superior	34%	57%
Inferior	35%	52%
Nasal	34%	38%
Temporal	33%	43%

The highest rates of closed angles on Gonioscopy and AS OCT images were observed in the Superior quadrant followed by Inferior quadrant. Anterior segment OCT tended to detect more closed ACAs than Gonioscopy, particularly in the Superior and Inferior quadrants. More persons are found to have Closed Angles with AS-OCT than with Gonioscopy. This may be due to the method used to classify Angle as closed on Gonioscopy and AS OCT. The Scleral Spur (SS) was used as an anatomic landmark to classify a closed angle in OCT images, whereas Trabecular meshwork (TM) was used for Gonioscopy as per the Shaffer grading system. Though the Gonioscopy is a traditional method and reference diagnostic standard for angle assessment, AS OCT is highly sensitive in detecting angle closure when compared with Gonioscopy. AS OCT because of its non-invasive nature, high-resolution images, rapid scanning speed, storage capacity, imaging in the presence of corneal opacities and the ability to provide both qualitative and quantitative analysis of the Angle recess make it an important diagnostic tool for disease documentation, progression and therapeutic outcomes.

4. Conclusion

The present study attempted to compare accuracy of the results of Gonioscopy and AS OCT in detecting angle closure in Glaucoma patients. We found the agreement between Gonioscopy and AS OCT in detecting angle closure to be 'Moderate to Good'.

However, Gonioscopy and AS OCT imaging do not always agree in the Angle Closure assessments, but have their own advantages (Gonioscopy can distinguish appositional versus synechial angle closure, OCT imaging is more objective and rapidly performed without patient discomfort) and should be used together and not exclusively.

5. Source of Funding

None.

6. Conflict of Interest

None.

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