Original Research Article

Comparative study of anterior chamber parameters in angle closure glaucoma spectrum with normal individuals with Scheimpflug imaging

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Abstract

Background: Primary Angle Closure glaucoma (PACG) is an aggressive and visually destructive disease with estimation that it blinds five times more people than primary open angle glaucoma. Anterior chamber angle and depth have been identified as an important risk factor for angle-closure glaucoma. In present study we aimed to compare anterior chamber parameters in angle closure glaucoma spectrum with normal individuals with Scheimpflug imaging. **Material and Methods:** Present study was single-center, prospective, comparative, parallel-group, randomized study, conducted in glaucoma suspect patients, patients with AAC, including involved eye, controlling the acute attack, as cases. Normal individuals accompanying with other patients as controls. **Results:** In present study sample size was 70 eyes in each group. Group A was primary angle closure glaucoma spectrum patients and Group B include normal individual with normal eyes. In present study patients were from age group between 51 - 60 years in both the groups i.e. 16 (54.71%) in group A (Angle closure glaucoma spectrum eyes) and 17 (48.57%) in group B (eyes of normal individual). Female patients were more than male patients in both the groups. Primary angle closure suspects eyes were most common (61.42%), followed by PACG (20.00%) and primary angle closure (15.71%). Anterior chamber parameters in both the groups were more in group B (eyes of normal individual) than in group A (Angle closure glaucoma spectrum eyes). This difference was statistically significant in all parameters. Also ACV/AL, ACV/KERATOMETRY, ACV/WTW, ACV/LT were more in group B(eyes of normal individual) than group A(Angle closure glaucoma spectrum eyes) and this difference was statistically significant. **Conclusion:** Scheimpflug imaging can be a very useful tool in differentiating angle closure glaucoma spectrum from normal individuals, but, it cannot differentiate between the patients within the spectrum like primary angle closure suspect versus primary angle closure versus primary angle closure glaucoma.

Keywords: anterior chamber parameters, angle closure glaucoma, Scheimpflug imaging, gonioscopy.

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INTRODUCTION

Glaucoma affects approximately 67 million people making it the most common cause of irreversible blindness worldwide.[1] Although constituting only about 26% of all glaucoma, Primary Angle Closure glaucoma (PACG) is an aggressive and visually destructive disease with estimation that it blinds five times more people than primary open angle glaucoma[2] making it an important public health problem. To effectively prevent PACG by the use of prophylactic laser iridotomy, it is necessary to identify people with anatomically narrow angle.[3] It has been shown that without treatment, 22% of PACS eyes progress to

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PAC over a period of 5 years. Additionally, the 5-year incidence for progression from PAC to PACG was shown to be 28.5%.[4] As damage by acute angle closure (AAC) is irreversible, prophylactic laser peripheral iridotomy (LPI) of PACS eyes with high risk characteristics for developing AAC is crucial.[5] Anterior chamber angle and depth have been identified as an important risk factor for angle-closure glaucoma. Apart from gonioscopy quantitative imaging modalities such as ultrasound biomicroscopy, optical coherence tomography, and Scheimpflug imaging have been developed for Anterior chamber measurements.[6,7] The most versatile being, a noninvasive noncontact method which uses a single rotating Scheimpflug camera for anterior segment imaging in a quantitative and reproducible way. Anterior segment imaging modalities such as Scheimpflug imaging may help define and detect high risk eyes. So, Gonioscopy is a subjective finding to detect Angle closure glaucoma spectrum, Anterior Chamber Parameters measured with Scheimpflug imaging can be an objective method for diagnosis and make intervention in angle closure glaucoma spectrum.[5] In present study we aimed to compare anterior chamber parameters in angle closure glaucoma spectrum with normal individuals with Scheimpflug imaging.

MATERIAL AND METHODS

Present study was single-center, prospective, comparative, parallel-group, randomized study, carried out in Glaucoma Department of M.M. Joshi Eye Institute, Gokul Road, Hubli, Karnataka, India. Study duration was of 2 years (July 2018 to June 2019). Study was approved by institutional ethical committee.

INCLUSION CRITERIA:

- Glaucoma suspect
- In patients with AAC, including involved eye, controlling the acute attack, the unaffected fellow eye was considered for the study before receiving any medication.
- Normal individuals accompanying with other patients

EXCLUSION CRITERIA:

- Patients with peripheral iridotomy, anti-glaucoma medication, post trabeculectomy / valve surgery
- Pseudophakic individuals
- Optic nerve disease
- Any other ocular disease
- Uveitis / secondary glaucoma

Informed valid consent of patient taken. Group A includes (65) eyes of angle closure glaucoma spectrum patients. Group B includes (65) eyes of normal individuals All patients recruited in the study were evaluated with detailed history. A thorough physical examination was carried out in all patients including assessment of other systems for any related contributory pathology. All patients undergone a complete ophthalmologic examination. All eligible eyes undergone anterior segment imaging using Scheimpflug (Sirius) imaging and IOL Master. Anterior segment parameters including anterior chamber volume (ACV), anterior chamber angle (ACA), anterior chamber depth (ACD) from the endothelium, central corneal thickness (CCT) and keratometry (KR) was measured by Scheimpflug imaging. For each patient, Scheimpflug imaging was performed twice within a 5-minute interval and the mean values were considered for analysis. The ACA, ACV and ACD measurements were obtained in each Scheimpflug image. All measurements were performed automatically with the Scheimpflug imaging, custom software that enabled the creation of an angle and measured the distance between the optical signals with the highest reflectivity at the tissue using iris and posterior cornea surface as the reference plans. The horizontal line (nasal and temporal), and only the smaller angle of the two measurements (nasal and temporal) was automatically adopted. Lens thickness (LT), vitreous length (VL) and axial length (AL) were measured using IOL master. Although measurement of lens thickness and densitometry are possible with Scheimpflug imaging, these were not obtained because they require pupil dilatation. White to white corneal diameter is also measured by IOL Master. Data was collected and compiled using Microsoft Excel 2013, analysed using SPSS 23.0 version and Open Epi Software Version 2.3 by calculating frequency, percentage and cross-tabulations between various parameters. The means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi-square test or Fisher exact test as applicable.

RESULTS

In present study sample size was 70 eyes in each group. Group A was primary angle closure glaucoma spectrum patients and Group B include normal individual with normal eyes. In present study patients were from age group between 51 - 60 years in both the groups i.e. 16 (54.71%) in group A (Angle closure glaucoma spectrum eyes) and 17 (48.57%) in group B (eyes of normal individual) followed by 40 - 50 yrs. 12 (34.28%) in group A and 13 (37.14%) in group B. Female patients were more than male patients in both the groups. It was 23 (65.71%) in group A and 24 (68.57%) in group B.

Table 1: Distribution of patients according to Age and gender

	Group A N (%)	Group B N (%)	Total N (%)
Age Group (years)			
40 to 50	12 (34.28)	13 (37.14)	25 (35.71)
51 to 60	16 (45.71)	17 (48.57)	33 (47.14)
61 to 70	06 (17.14)	05 (14.28)	11 (15.71)
>70	01 (02.85)	00 (00.00)	01 (01.42)
Gender			
Male	12 (34.28)	11 (31.42)	23 (32.85)
Female	23 (65.71)	24 (68.57)	47 (67.14)

In present study primary angle closure suspects eyes were most common (61.42%), followed by PACG (20.00%) and primary angle closure (15.71%).

Table 2: Distribution of Eyes according to Diagnosis

Diagnosis	Frequency	Percentage (%)
Primary Angle Closure Suspect	43	61.42
Primary Angle Closure	11	15.71
PACG	14	20.00
Acute Angle Closure crisis	02	02.85

In present study anterior chamber parameters in both the groups were more in group B (eyes of normal individual) than in group A (Angle closure glaucoma spectrum eyes). This difference was statistically significant in all parameters. Also ACV/AL, ACV/KERATOMETRY, ACV/WTW, ACV/LT were more in group B(eyes of normal individual) than group A(Angle closure glaucoma spectrum eyes) and this difference was statistically significant.

Table 3: Comparison of Anterior chamber Parameter

Parameter	Group A (Mean±SD)	Group B (Mean±SD)	P value
ACD	2.00±0.26	2.84±0.25	0.001
ACV	73.76±17.00	139.20±14.15	0.001
ACA	27.64±7.06	42.06±7.12	0.001
ACV/AL	3.30±0.74	6.02±0.63	0.001
ACV/KERATOMETRY	1.65±0.39	3.15±0.32	0.001
ACV/WTW	6.33±1.39	11.62±1.17	0.001
ACV/LT	16.11±4.08	34.63±4.44	0.001

All anterior chamber parameters were more in PAC eyes than in PACS eyes and this difference was statistically significant in all parameters (p value <0.05) except in ACV/AL and in ACV/WTW. (P value>0.05)

Table 4: Comparison between PACS and PAC

Parameter	PACS (Mean±SD)	PAC (Mean±SD)	P value
ACD	2.00±0.24	2.20±0.25	0.01
ACV	73.40±14.36	85.91±24.75	0.03
ACA	26.56±5.36	32.45±8.05	0.005
ACV/AL	3.32±0.65	3.76±1.04	0.08
ACV/KERATOMETRY	1.62±0.31	1.97±0.61	0.01
ACV/WTW	6.31±1.20	7.18±1.93	0.06
ACV/LT	15.98±3.52	19.05±5.71	0.02

In comparison between PACS and PACG for anterior chamber parameters, all parameters were more in PACS eyes than in PACG eyes, this difference was not statistically significant in all above parameters (p value>0.05)

Table 5: Comparison between PACS and PACG

Parameter	PACS (Mean±SD)	PACG (Mean±SD)	P value
ACD	2.00±0.24	1.86±0.24	0.06
ACV	73.40±14.36	68.29±13.06	0.24
ACA	26.56±5.36	29.36±7.75	0.13
ACV/AL	3.32±0.65	3.04±0.55	0.15
ACV/KERATOMETRY	1.62±0.31	1.54±0.30	0.40
ACV/WTW	6.31±1.20	6.02±1.18	0.43
ACV/LT	15.98±3.52	14.98±3.14	0.34

In comparison between PACS and Acute Angle closure crisis, for anterior chamber parameters, all parameters were more in PACS eyes than in Acute Angle closure crisis eyes and this difference was statistically significant (p value <0.05) except in ACD.

Table 6: Comparison between PACS and Acute Angle closure crisis

Parameter	PACS (Mean±SD)	Acute Angle Closure crisis (Mean±SD)	P value
ACD	2.00±0.24	1.74±0.22	0.14
ACV	73.40±14.36	53.00±5.65	0.05
ACA	26.56±5.36	12.50±0.70	0.001
ACV/AL	3.32±0.65	2.37±0.27	0.05
ACV/KERATOMETRY	1.62±0.31	1.18±0.15	0.05
ACV/WTW	6.31±1.20	4.46±0.58	0.03
ACV/LT	15.98±3.52	10.67±1.32	0.04

In comparison between PAC and PACG for anterior chamber parameters, all parameters were more in PAC eyes than in PACG eyes and this difference was statistically significant (p value <0.05) except in ACA and ACV/WTW. (P value>0.05)

Table 7: Comparison between PAC and PACG

Parameter	PAC (Mean±SD)	PACG (Mean±SD)	P value
ACD	2.20±0.25	1.86±0.24	0.002
ACV	85.91±24.75	68.29±13.06	0.03
ACA	32.45±8.05	29.36±7.75	0.34
ACV/AL	3.76±1.04	3.04±0.55	0.03
ACV/KERATOMETRY	1.97±0.61	1.54±0.30	0.03
ACV/WTW	7.18±1.93	6.02±1.18	0.07
ACV/LT	19.05±5.71	14.98±3.14	0.03

In comparison between PAC and Acute Angle closure crisis for anterior chamber parameters, all parameters were more in PAC eyes than in Acute angle closure crisis eyes and this difference was not statistically significant except in ACD, ACA which was significant.

Table 8: Comparison between PAC and Acute Angle closure crisis

Parameter	PAC (Mean±SD)	Acute Angle Closure crisis (Mean±SD)	P value
ACD	2.20±0.25	1.74±0.22	0.03
ACV	85.91±24.75	53.00±5.65	0.09
ACA	32.45±8.05	12.50±0.70	0.006
ACV/AL	3.76±1.04	2.37±0.27	0.09
ACV/KERATOMETRY	1.97±0.61	1.18±0.15	0.10
ACV/WTW	7.18±1.93	4.46±0.58	0.08
ACV/LT	19.05±5.71	10.67±1.32	0.07

In comparison between PACG and Acute Angle closure crisis for anterior chamber parameters, all parameters were more in PACG eyes than in Acute angle closure crisis eyes and this difference was not statistically significant (p value>0.05).

Table 9: Comparison between PACG and Acute Angle closure crisis

Parameter	PACG (Mean±SD)	Acute Angle Closure crisis (Mean±SD)	P value
ACD	1.86±0.24	1.74±0.22	0.52
ACV	68.29±13.06	53.00±5.65	0.13
ACA	29.36±7.75	12.50±0.70	0.01
ACV/AL	3.04±0.55	2.37±0.27	0.12
ACV/KERATOMETRY	1.54±0.30	1.18±0.15	0.12
ACV/WTW	6.02±1.18	4.46±0.58	0.09
ACV/LT	14.98±3.14	10.67±1.32	0.08

DISCUSSION

Glaucoma is a leading cause of irreversible blindness and managing glaucoma patients is a real challenge for ophthalmologists worldwide. Of the several causes for glaucoma, ocular hypertension (increased pressure within the eye) is the most important risk factor in most glaucomas, but in some populations, only 50% of people with primary open-angle glaucoma actually have elevated ocular pressure.[8] Scheimpflug photography is the basis for a number of devices that can image the anterior segment. The technology is highly versatile, with potential applications in the areas of keratorefractive surgery,

corneal biomechanics, corneal ectasia evaluation, anterior segment imaging, cataract grading, and surgical planning for femtosecond laser-assisted cataract surgery.[9,10] In our study, the comparison between group A (primary angle closure glaucoma spectrum) and group B (normal individual) with respect to anterior chamber parameters ACD, ACV, ACA. We have compared ACD, ACV, AC, ACV/AL, ACV/KERATOMETRY, ACV/WTW and ACV/LT parameters which were more in group B (normal individual) than in group A(primary angle closure glaucoma spectrum). DS Grewal *Et al.* conducted a prospective, cross-sectional observational study, 265 eyes of 265 consecutive patients underwent sequential Scheimpflug imaging, SD- ASOCT imaging, and gonioscopy. Correlations between gonioscopy grading, ACV, ACD, AOD 500 and TISA500 were evaluated. It was concluded that ACV measurements using Scheimpflug imaging outperformed AOD500and TISA500 using SD-ASOCT for detecting narrow angles.[3] Mohammad Pakravan *et al.*[11] studied comparison between acute angle closure, PACS and normal eyes in which they mentioned that Mean anterior chamber volume was 72±18, 77±18 and 176±44 µl in these groups and were statistically significant. They also compared ACA, ACD and observed that it was statistically significant as in our study. Also anterior chamber volume in primary angle closure suspects before and after peripheral iridotomy in which they found significant difference. In another study by George *et al.*,[12] no significant difference in biometric values was found between angle closure glaucoma and occludable angles, however they were significantly different from normal eyes; this observation is also in line with our findings. Jong Rak Lee *et al.*,[13] also studied ACA, ACD and ACV parameters before and after laser peripheral iridotomy and the difference was statistically significant and the basic parameters of ACV and deepest ACD and all of the advanced topographic ACD parameters (Central ACD, Mid1 ACD, Mid2 ACD, and Mid3 ACD) increased significantly in both the conventional and LPI plus iridoplasty groups. Matthew T. Feng *et al.*,[14] studied ACD in normal individuals using Scheimpflug imaging mentioned that ACD did not vary significantly in the countries studied, with the notable exception of New Zealand. Surgeons should anticipate a greater likelihood of a shallow ACD when evaluating glaucoma patients Middle-aged subjects had more crowded anterior chambers than young subjects with similar axial lengths. Anterior chamber volume may be a more sensitive parameter to reveal this difference than a linear measurement of the anterior chamber depth. Anterior segment imaging modalities such as Scheimpflug imaging may help define and detect high risk eyes.

Limitations of present study were small sample size and short duration of study.

CONCLUSION

In present study all anterior chamber parameters were more in normal eyes compared to angle closure glaucoma spectrum and mean difference was significant. Scheimpflug imaging can be a very useful tool in differentiating angle closure glaucoma spectrum from normal individuals, but, it cannot differentiate between the patients within the spectrum like primary angle closure suspect versus primary angle closure versus primary angle closure glaucoma.

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