ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (*IJMSIR*)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 6, Issue – 2, April – 2021 , Page No. : 35 - 40

A study of efficacy of scheimpflug imaging in identifying eyes at risk of developing acute angle closure attack among primary angle closure glaucoma patients

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Citation this Article: Dr Shilpa Jalwaniya, Dr Manish Sharma, Dr Kamlesh Khilnani, "A study of efficacy of scheimpflug imaging in identifying eyes at risk of developing acute angle closure attack among primary angle closure glaucoma patients", IJMSIR- April - 2021, Vol – 6, Issue - 2, P. No. 35 – 40.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Purpose: To identify eyes at higher risk of developing acute angle closure attack among primary angle closure glaucoma patients using scheimpflug imaging technique.

Methods: This hospital based comparative type of cross-sectional observational analysis study was conducted on patients attending Glaucoma clinic of Upgraded Department of Ophthalmology, SMS Medical College and Hospital, Jaipur. After classifying the subjects into three groups namely PACG; POAG & Normal, anterior chamber parameters (ACV, ACD, ACA) were measured using Pentacam. Statistical analysis was done by using chi square test at alpha error 0.05 and power 80%.

Result: Eyes with ACV ≤100 µl; ACD ≤2.19 mm; ACA was ≤26° were at higher risk of developing acute angle closure attack.

Conclusion- The current study finds that measuring anterior chamber parameters (ACV, ACD, ACV) using schiempflug imaging technique (Pentacam) can identify eyes at higher risk of developing AAC. Furthermore, these criteria can be also helpful while making a decision to perform prophylactic laser PI in borderline cases.

Keywords: Acute angle closure attack (AAC); Scheimpflug imaging; Anterior chamber volume (ACV); Anterior chamber depth (ACD); Anterior chamber angle (ACA).

Introduction

The concept of glaucoma has evolved in the past 100 years[1], and still remains imprecise and subject to technical qualifications. The word glaucoma originally meant 'clouded' in Greek. Glaucoma is the leading cause of irreversible blindness worldwide and is second only to cataract as the most common cause of blindness overall.[2] Glaucoma affects more than 67 million people worldwide, of whom about 10%, or 6.6 million, are estimated to be blind.[3] Glaucoma is responsible for 14% of all blindness [4]. Primary angle closure glaucoma (PACG) is highly prevalent in the

Asian populations. Traditionally, gonioscopy is the gold standard method for identifying occludable angles. However, it is a subjective technique requiring skill and could be uncomfortable for patients. Thus, an imaging technique that is largely independent of the operator's judgment is desirable. Methods to evaluate the anterior chamber angle (ACA) like ultrasound biomicroscopy and anterior segment optical coherence tomography have been shown to represent the ACA width objectively and quantitatively, but it is time consuming and relatively operator dependent to determine ACA values. Ultrasound biomicroscopy is accurate on the measurement of anterior chamber angle, but also carries the disadvantage of being a contact method. While in scheimpflug imaging system, all the measurements get performed automatically with the instrument software that enables the creation of an angle. It calculates the anterior chamber angle as the distance between the optical signals with the highest reflectivity at the tissue using iris and posterior cornea surface as the reference planes. The scheimpflug images the anterior segment of the eye, by a rotating Scheimpflug camera measurement system. This rotating process supplies three-dimensional pictures. The measurement process lasts less than two seconds and minute eye movements that are captured and corrected simultaneously. It promises to overcome the limitations of the gonioscopy and UBM (ultrasound biomicroscopy) and is an excellent tool for assessment of angle structure.

In our study, we measured the anterior chamber parameters of normal subjects and patients with primary glaucoma (primary angle closure glaucoma and primary open-angle glaucoma) by a rotating scheimpflug camera and compared the parameters between different groups.

Material And Methods

This hospital based comparative type of cross-sectional observational analysis study was conducted on patients attending Glaucoma clinic of Upgraded Department of Ophthalmology, SMS Medical College and Hospital, Jaipur.

The subjects were between 21-60 years of age. The inclusion criteria in the study groups was as following: A) Patients of Primary open angle glaucoma (POAG): glaucomatous optic disc and field changes associated with IOP >21mmHg by Goldmann tonometer, a normal appearing anterior chamber angle on gonioscopy and no any secondary cause of elevated IOP. B)Patients of Primary angle closure glaucoma (PACG): history of previous acute angle closure (AAC) attack in one eye and unaffected fellow eye. C) Normal individuals : IOP <21mmHg, normal appearing anterior chamber angle on gonioscopy, normal anterior chamber depth, clear refractive media, normal eye fundus and best corrected visual acuity of 6/6. The exclusion criteria included corneal pathology, secondary glaucomas, ocular infection or inflammation, ocular trauma or surgery, retinal or optic nerve diseases. All patients underwent complete ophthalmological examination including best corrected Visual acuity on Snellen's chart, slit lamp biomicroscopy of the anterior segment, intraocular pressure using Goldmann Applanation Tonometer, gonioscopy using 3-mirror Goldmann lens, optic nerve head examination using 90 D lens. After informed consent, the subjects satisfying the inclusion and exclusion criteria were distributed into three study groups namely PACG; POAG & Normal with forty patients in each group. Study sample size was calculated at 80% study power and α error of 0.05 assuming standard deviation of 6.9˚ in anterior chamber angle. Anterior chamber parameters (ACV, ACD, ACA) were measured using Pentacam. A single experienced observer performed all Pentacam measurements. The subject was asked to place his/her chin on the chin rest and the forehead against the head rest. The subject was asked to open both eyes and look at the fixation target. The examiner aligned the joystick until the rotating Scheimpflug camera automatically captured 25 single images within 2 seconds for each eye. The measurements were checked under the quality specification window; only correct measurements were accepted. Maps with poor centration were repeated in order to provide a best-fit toric/ellipsoid reference surface.

Observations And Results

Total 120 patients were examined. Forty patients each in the three study groups: Primary angle closure glaucoma (PACG), Primary open angle glaucoma (POAG) and Normal subjects were analysed using unpaired student's t test. Mean age of PACG patients was 46.83 years, POAG patients was 47.58 years and that of normal subjects was 43.75 years. There was no statistically significant difference between these three groups.

Table 1: Central Anterior chamber depth (CACD) (in mm)

	Mean CACD	SD
PACG	1.96	0.19
POAG	2.71	0.18
Normal	2.85	0.10
P value*	P<0.001	

Table 1 shows mean anterior chamber depth in PACG patients was 1.96±0.19 mm, in POAG patients was 2.71±0.18mm and in normal subjects was 2.85±0.10 mm. There was statistically significant difference between these three groups.

Table no. 2 Anterior chamber Volume(ACV) (in $mm^{3)}$

	Mean ACV	SD
PACG	84.59	18.46
POAG	154.93	15.85
Normal	168.05	14.05
P value*	P<0.001	

Table 2 shows mean anterior chamber Volume in PACG patients was 84.59±18.46mm^3, in POAG patients was 154.93±15.85 mm^3 and in normal subjects was 168.05±14.05 mm^3. There was statistically significant difference between these three groups.

Table 3: Anterior chamber Angle (ACA) (in degrees)

	Mean ACA	SD
PACG	20.81	3.57
POAG	29.45	2.75
Normal	30.58	2.27
P value*	P<0.001	

Table 3 shows mean anterior chamber Angle in PACG patients was 20.81±3.57 degrees, in POAG patients was 29.45±2.75 degrees and in normal subjects was 30.58±2.27 degrees. There was statistically significant difference between these three groups.

Table 4: Central Anterior chamber Depth (CACD)

	Mean CACD	SD
PACG eye	1.96	0.13
Fellow eye	2.01	0.18
P value*	0.106	

Table 4 shows mean anterior chamber depth in PACG eye was 1.96±0.19 mm, in fellow eye was 2.01±0.18mm. There was no statistically significant difference between these two groups.

Table 5: Anterior chamber Volume (ACV)

	Mean ACV	SD
PACG eye	82.32	10.18
Fellow eye	89.97	9.34
P value*	0.0007	

Table 5 shows mean anterior chamber volume in PACG eye was 82.32±10.18mm^3, in fellow eye was 89.97±9.34 mm^3. There was statistically significant difference between these two groups.

Table 6: Anterior chamber angle (ACA)

	Mean ACA	SD
PACG EYE	20.83	3.22
Fellow eye	23.25	3.25
P value*	0.001	

Table 6 shows mean anterior chamber angle in PACG eye was 20.83±3.22 degrees, in fellow eye was 23.25±3.25 degrees. There was statistically significant difference between these two groups.

Discussion

In this study we evaluated and compared anterior segment and ocular biometric variables among unaffected fellow eyes of patients, with a previous attack of AAC, POAG eyes and normal eyes using Pentacam. We looked for predictive parameters to identify eyes at high risk for developing AAC. The large AUCs found for ACV, ACA and ACD indicated that all three parameters are probably powerful indicators for determining the risk of AAC with cut off values of ACV ≤100 µl, ACA≤23.25°, and ACD ≤2.19mm.

Although less common than chronic angle closure glaucoma, AAC is a dramatic condition resulting in irreversible damage. An attack of AAC may result in peripheral field loss from ischemic damage to the optic nerve head, some loss of visual acuity even in subjects receiving early treatment and also endothelial cell loss with attacks of more than 3 days' duration.[5] For these reasons, AAC attacks must be prevented if at all possible. These eyes show an anatomical predisposition as evident by a crowded anterior segment which is usually bilateral, and any case with unilateral AAC and normal fellow eye should be diagnosed as secondary angle closure glaucoma. The unaffected fellow eye is at high risk of developing AAC.[6] Without treatment, this may occur simultaneously or at any time after the initial attack, most commonly in the first month.[5]

In a population based study of Thomas R et al[6] shown that over a period of 5 years, 22% of eyes categorized as PACS may progress to PAC, however no predictive parameter was recognized. Prophylactic administration of miotics such as pilocarpine although frequently used until laser peripheral iridectomy can be performed are ineffective for long term prevention of the acute attack.

Laser peripheral iridotomy is effective and the major preventive measure to decrease such risk in the fellow eye. Although LPI is easily performed, it may be accompanied by complications among which progression of cataracts and bullous keratopathy are most important.[7-8] Thus LPI has not been recommended for all patients with anatomically narrow angles.[9] A more practical approach would be to distinguish eyes at high risk of developing AAC which has been a subject of great interest.

Advances in anterior segment imaging have allowed quantitative and reproducible measurement of anterior segment parameters. The Pentacam is a non-invasive noncontact method which uses a single rotating Scheimpflug camera for anterior segment imaging in a quantitative and reproducible way. It takes up to 50 slit images of the anterior segment in 2 seconds with 500 true elevation points in each image. A 3-dimensional model of the anterior segment is then constructed using the obtained data, and corneal thickness, corneal topographic parameters, central ACD, ACA, ACV and some other parameters can be measured.[11]

Konstantopoulos A et al [13] Stated that rotating Scheimpflug imaging (Pentacam-Scheimpflug) and anterior segment optical coherence tomography (Visante OCT and Slit-Lamp OCT), supplement the more established imaging devices of Orbscan scanning slit topography and ultrasound biomicroscopy (UBM) and promise quantitative information and qualitative imaging of the cornea and anterior chamber, and provide a quantitative angle estimation by calculating the angle between the iris surface and the posterior corneal surface.

Hong S et al [14] Stated that quantitative angle parameters and anterior chamber depths, as measured by PTC, have similar mean values, reproducibility, and sensitivity-specificity profiles when compared with measurements obtained by AOCT due to ease of image acquisition and the non-contact nature.

Conclusion

The findings of present study reveal that eyes with ACV ≤100 μl can be considered at high risk; ACD ≤2.19 mm is another considerable risk factor for development of AAC; corresponding values for ACA is ≤26°. Furthermore, any eye that meets all of these three criteria (ACV ≤100 μl, ACA ≤26.5° and ACD ≤2.19 mm) is strongly at higher risk of developing acute angle closure attack.

To conclude, anterior chamber volume, depth and angle as measured by Pentacam are found to be reliable parameters for identifying eyes at high risk of developing acute angle closure attack. These criteria are also helpful while making a decision, whether to perform prophylactic laser PI or not in borderline cases.

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