

Prevalence of plateau iris configuration in primary angle closure glaucoma using ultrasound biomicroscopy in the Indian population

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Purpose: To report the prevalence of plateau iris in patients with primary angle closure glaucoma (PACG), in North India. **Materials and Methods:** The patients with PACG, attending the glaucoma services at a tertiary care center in North India were included in the study. All patients had undergone Nd-YAG laser peripheral iridotomy at least four weeks prior to inclusion in the study. Four weeks prior to inclusion in the study, none of the patients had used pilocarpine. Ultrasound Biomicroscopy (UBM) images were qualitatively evaluated and plateau iris configuration was defined in an eye if the following criteria were fulfilled in two or more quadrants: anteriorly directed ciliary process supporting the peripheral iris, steep rise of iris root from its point of insertion followed by a downward angulation from the corneoscleral wall, absent ciliary sulcus, and iridotrabecular contact in the same quadrant. **Results:** One hundred and one eyes were included in the study. There were 63 (62.4%) females and 38 (37.6%) males. The mean age of the patients was 57.8 ± 9.5 years (range: 42 to 78 years). The mean axial length in the study population was 22.2 ± 1.1 mm. The mean spherical equivalent refraction was 0.06 ± 1.12 D. The mean intraocular pressure was 18.5 ± 4.7 mmHg (range: 12 – 24 mmHg). Twenty-nine (28.7%) subjects were diagnosed with plateau iris on the basis of above-defined criteria. Of the 29 eyes, 18 (62.1%) subjects had plateau iris in two quadrants, nine (31.03%) in three quadrants, and two (6.8%) had this configuration in all the four quadrants. **Conclusions:** Approximately 30% of the eyes with PACG had plateau iris on UBM. Plateau iris was very often the cause for residual angle closure following laser peripheral iridotomy in Indian eyes with PACG.

Key words: Plateau iris, primary angle closure glaucoma, prevalence

Glaucoma is one of the important causes of preventable blindness and the number of primary Glaucoma patients is likely to increase to 60.5 million by this year.^[1] Primary angle closure glaucoma (PACG) may account for half of the subjects with primary glaucoma worldwide,^[2] the prevalence being more common in Asians.^[1] Also, it is more likely to cause visual impairment than primary open-angle glaucoma.^[3] In India, the prevalence of PACG has a high of 4.32% in the Vellore Eye Study^[4] and 0.71% in the Andhra Pradesh Eye Disease study.^[5]

Non-pupil block mechanisms may be responsible for a significant proportion of angle closure in Asians,^[6] plateau iris being one of them. It has traditionally been defined as an occludable angle on gonioscopy, with a flat iris plane and a relatively deep central anterior chamber.^[7] Various theories have been given regarding the pathogenesis of plateau iris. These include an anomaly in structure or position of the ciliary body,^[8] disproportionate size of the lens,^[9] anterior rotation of the ciliary processes,^[10] anomaly in the size, and insertion of the iris root.^[11] Ritch suggested that the ciliary processes were anteriorly rotated, anteriorly positioned or abnormally large in cases of plateau iris syndrome (PIS).^[12] Ultrasound biomicroscopy (UBM) offers an objective investigation for assessing the relationship of the peripheral iris with the ciliary processes.^[13]

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The prevalence of plateau iris configuration (PIC) in cases of PACG has been evaluated and the results range from 31 to 60%.^[14,15] However, there are no published studies with standardized UBM criteria in the Indian population. Therefore, the present study has been undertaken to determine the prevalence of plateau iris in Indian subjects with PACG, using ultrasound biomicroscopy.

Materials and Methods

This cross-sectional study was carried out at a tertiary care eye center; Dr. Rajendra Prasad Center for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi between 1 January, 2010 and 30 September, 2010. Subjects attending the glaucoma services of the institution were recruited for the study. A written informed consent was taken from all the participants. The study conformed to the ethical standards of the Declaration of Helsinki.

All subjects underwent a comprehensive ophthalmic examination including best corrected visual acuity (BCVA), measurement of intraocular pressure (IOP) with Goldmann applanation tonometry, Humphrey Visual Field (HVF) 30-2 Standard Automated Perimetry (Humphrey Visual Field Analyzer II, Carl Zeiss Meditec, Dublin, California), and stereoscopic evaluation of the optic nerve head with a +90 D lens. Gonioscopy was performed with a Susmann 4-mirror gonioscope, in the primary position and after indentation, under low illumination and high magnification (16x).

Patients with PACG were included. The subjects were identified by the presence of glaucomatous optic neuropathy (a cup-disc ratio of $>0.7 : 1$ and / or notching of the neuroretinal rim and / or nerve fiber layer defects corroborating with the

visual field changes), and gonioscopy findings of non-visibility of the posterior trabecular meshwork in more than 180 degrees of angle circumference with a Sussman gonioscope in the primary position, with the presence of peripheral anterior synechiae. In all subjects, the gonioscopy was performed by a single examiner (TD). All the patients were treated with Nd-Yag laser peripheral iridotomy at least four weeks prior to inclusion in the study. Eyes with a history of an acute attack of primary angle closure glaucoma, secondary angle closure, patients on pilocarpine therapy, and patients with history of previous laser iridoplasty or intraocular surgery were excluded from the study.

All subjects were subjected to a UBM examination, using a 50-MHz transducer (P40 machine Paradigm Medical Industries, Salt Lake City, UT), under dark room conditions. Under topical anesthesia, a plastic eye cup was used to separate the lids. Methylcellulose 2.5% was used as the coupling agent. UBM was performed in a dark room, with only a UBM machine monitor on and no ambient light from an external source, the probe was held perpendicular to the ocular surface and care was taken to prevent the eye cup from compressing the globe. A radial scan was done in all the four quadrants. A single observer (GK) performed all the UBM scans. In subjects with bilateral PACG, one eye was randomly selected for analysis. One clear and representative image of each of the quadrants was selected for further analysis. The acquired UBM images were analyzed by an independent experienced observer (TD) blinded to the clinical information. The presence of ciliary sulcus was evaluated in all the four quadrants. The criteria used to define the ciliary sulcus were taken as: presence of a clear space between the anterior face of the ciliary body and the iris.

On the basis of the UBM examination, plateau iris was defined in a quadrant when all the following criteria were fulfilled, as previously published;^[14]

1. The ciliary process was anteriorly directed, supporting the peripheral iris so that it was parallel to the trabecular meshwork.
2. The iris root had a steep rise from its point of insertion, followed by a downward angulation from the corneoscleral wall.
3. An absent ciliary sulcus.
4. Irdoangle contact (above the level of the scleral spur) in the same quadrant.

An eye was labeled to have plateau iris configuration (PIC) when at least two quadrants fulfilled the above-mentioned criteria.

Statistical analysis was performed using the SPSS 10 software (2008, Chicago, IL). A chi square test was used for analysis. A *P* value < 0.05 was considered significant.

Results

One hundred and one subjects with primary angle closure glaucoma were included in the study [Table 1]. There were 63 (62.4%) females and 38 (37.6%) males. The mean age of the patients was 57.8 ± 9.5 years (range: 42 to 78 years). The mean axial length in the study population was 22.2 ± 1.1 mm. The mean spherical refraction was 0.06 ± 1.12 D. The mean intraocular pressure was 18.5 ± 4.7 mm Hg (Range: 12 – 24 mm Hg). The Nd : YAG iridotomy was patent in all the

eyes. None of the patients gave a history of a previous attack of acute angle closure. On analysis of the UBM images, 29 (28.7%) subjects were diagnosed to have plateau iris on the basis of the above-defined criteria [Fig. 1]. Among these subjects, 18 were females and 11 were males (*P* = 0.31).

As depicted in Table 2, further quadrant-wise analysis showed that 18 (62.1%) subjects had plateau iris in two quadrants, nine (31.0%) subjects in three quadrants, and two (6.8%) subjects had this configuration in all the four quadrants. The superior quadrant was the most commonly involved quadrant (*n* = 28), followed by inferior (*n* = 23), nasal (*n* = 13), and temporal (*n* = 12) quadrants. None of the PACG cases showed evidence of uveal effusion, on UBM.

Discussion

The gonioscopy findings of plateau iris include iridotrabecular apposition in the presence of patent iridotomy in a dark room; an anteriorly and centrally angled peripheral iris; a flat or slightly convex iris, and the sign of a double hump on indentation caused by the anterior concavity of the iris at the lens equator level.^[16] Diagnosis using gonioscopy can

Table 1: Characteristics of the study population (n = 101)

Females	63 (62.4%)
Males	38 (37.6%)
Mean age	57.8 + 9.5 yrs
Mean Axial length	22.2 + 1.1 mm
Mean Spherical Equivalent Refractive error	0.06 + 1.12 D
Mean intraocular pressure	18.5 + 4.7 mm Hg



Figure 1: Ultrasound biomicroscopy image showing anteriorly directed ciliary processes, a steep rise of the iris from the root, followed by downward angulation and iridotrabecular contact

Table 2: Quadrant-wise analysis of plateau iris configuration (n = 29)

No. of quadrants involved	No. of subjects	Percent
2	18	62.1
3	9	31.0
4	2	6.8

be subjective and has lower reproducibility than a diagnosis based on images of the angle.^[12] The sine-wave sign defined in gonioscopy is a soft sign and has not been validated.^[17]

Ultrasound biomicroscopy plays a fundamental role in the diagnosis of plateau iris configuration.^[13] The UBM criteria used for diagnosis of plateau iris in the previous studies include presence of all the following findings in two or more quadrants: anteriorly directed ciliary process supporting the peripheral iris, steep rise of the iris root from its point of insertion, followed by a downward angulation from the corneoscleral wall, a central flat iris plane, absent ciliary sulcus, and iridoangle contact in the same quadrant.^[14,18] We have included all but one criteria for the diagnosis, that is, a central flat iris plane, because we believe that a central flat iris plane may also be seen in cases of pupillary block glaucoma after a peripheral iridotomy.

A UBM study from India reported persistence of narrow angles after LPI in 60% of PACG eyes, and using UBM, the authors found an anteriorly positioned ciliary process with a narrow ciliary sulcus in 67% of such eyes.^[19] It is of note here that the number of quadrants involved and absent ciliary sulcus is not specified in the inclusion criteria. As anteriorly positioned ciliary processes have also been found in cases with open angles after LPI, they have postulated that the presence of an anteriorly placed ciliary process alone does not cause plateau iris. These findings are supported by similar results reported by Sakata *et al.*, who found an absent ciliary sulcus and long ciliary processes in 32% of the normal eyes.^[20]

In our study, we observed that PIC was present in 28.7% of the cases with primary angle closure glaucoma. Similarly in a previous study, the prevalence of plateau iris has been found to be 32.8% in PACG patients from Singapore and 31.7% in the PACG cases from Thailand.^[14] In another study by the same authors, the prevalence of the same has been noted to be 32.3% in a patient population of primary angle closure suspects.^[18] The results emphasize the role of non-pupillary block mechanisms in the pathogenesis of PACG, especially in Asian eyes. This may also partly explain the failure of a peripheral iridotomy to control the intraocular pressure, leading to progression of glaucomatous optic neuropathy and a high rate of angle closure glaucoma in the Asian population.^[21]

In a prevalence study carried out in Japan, approximately one-third of the fellow eyes of patients with angle closure were found to have plateau iris configuration. Surprisingly, it was noted that the prevalence of plateau iris configuration in patients with open angle glaucoma was 19%, which was higher than expected, although it was lower than that in angle closure.^[21] However, it is of note that the number of subjects included in this study was relatively small. In another study from Japan, similar prevalence rates of PIC were seen; 35% of the cases with chronic angle closure glaucoma were noted to have plateau iris configurations.^[22] Filho *et al.* found prevalence rates of 10.2% in open angle glaucoma patients, with narrow angles, in the Brazilian population. Sixty-two percent of their patients were found to have complete plateau iris configurations.^[23]

The quadrant-wise analysis in our cases showed that the PIC was more prevalent in the superior quadrants, closely followed by the inferior quadrants. Similar results were found in other

studies.^[15,18,22] The clinical implications of the quadrant-wise location of the PIC were unclear.

There are a few limitations to our study. As there are no quantitative criteria for the diagnosis of PIC, the judgment of UBM images on the basis of morphology adds subjectivity to the diagnosis of this entity. We tried to minimize the bias by having an independent observer, who was blinded to the clinical information, to analyze the UBM images. As a single examiner analyzed the UBM images, inter-observer agreement could not be examined. Second, the UBM findings may be variable and may be affected by the imaging technique, UBM operator or lighting conditions. As a single person has performed the UBM in all the cases, in similar ambient light conditions, this bias may have been minimal. Third, the analysis of the angle in each quadrant has been based on a cross-sectional image of the angle. The variations in the quadrant, for example, the presence of peripheral anterior synechiae in the scan may not be representative of the remaining angle in the quadrant. As this was a one-time assessment, intra-observer and inter-observer agreement could not be obtained from this study.

Conclusion

About 30% of the cases with PACG were found to have plateau iris in the Indian population. UBM should be performed in all eyes with PACG where the angles fail to open after peripheral iridotomy, as plateau iris is a major cause for angle closure in these cases.

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