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Evaluation of anterior chamber angle under dark and light conditions in angle closure glaucoma: An anterior segment OCT study

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ABSTRACT

Aim: To evaluate changes of nasal and temporal anterior chamber angle (ACA) in subjects with angle closure glaucoma using Spectralis AS-OCT (SAS-OCT) under dark and light conditions.
Methods: Based on dark-room gonioscopy, 24 subjects with open angles and 86 with narrow angles participated in this study. The nasal and temporal angle opening distance at 500 μm anterior to the scleral spur (AOD500), nasal and temporal ACA were measured using SAS-OCT in light and dark conditions.
Result: In 2 groups, ACA and AOD500 in nasal and temporal quadrants were significantly greater in light compared to dark (all with $p = 0.000$). The AOD500 and ACA were significantly higher in nasal than temporal in measured conditions for 2 groups except the ACA and AOD500 of normal group measured in light. The difference between nasal and temporal in dark (29.07 ± 65.71 μm for AOD500 and 5.7 ± 4.07° for ACA) was greater than light (24.86 ± 79.85 μm for AOD500 and 2.09 ± 7.21° for ACA) condition. But the difference was only significant for ACA ($p = 0.000$). The correlation analysis showed a negative correlation between AOD500 and pupil diameter in temporal and nasal quadrants (both with $p = 0.000$). While temporal AOD500 difference correlated with spherical equivalent, temporal and asal gonioscopy, nasal AOD correlated with IOP, temporal and nasal gonioscopy.
Conclusions: Clinically important changes in ACA structure could be detected with SAS-OCT in nasal and temporal quadrants under different illumination intensity. The results could help in improvement of examination condition for better and more accurate assessment of individuals with angle closure glaucoma.

1. Introduction

Primary angle closure glaucoma (PACG) is the leading cause of visual morbidity in East Asian population [1,2]. The prevalence of PACG was reported to be 1.44% in general population and many of them still remain undiagnosed [3]. Small corneal diameter, plateau iris, shallow anterior chamber depth (ACD), short axial length, and narrow anterior chamber angle (ACA) have been reported as the biometric risk factors in development of the PACG [4–6].

Assessment of the angle width is a key in determining the susceptibility of a narrow angle. The gold standard for evaluation of the ACA has been Goldmann contact gonioscopy. However, it is limited because of its invasive nature, analysis of the findings is subjective and the visibility of the angle structure depends on the lighting condition [7].

Spectralis anterior segment optical coherence tomography (SAS-OCT) is a fairly novel technique that provides high-resolution imaging of the anterior segment of the eye with 760-nm infrared light. It is a fast imaging technique and its operation does not need professional skills. It provides the visualization of both peripheral quadrants of the ACA in a single SAS-OCT scan for the better diagnosis of the glaucoma. In addition, important quantitative and spatial data related to the changes of the angle structure can be obtained with this instrument.

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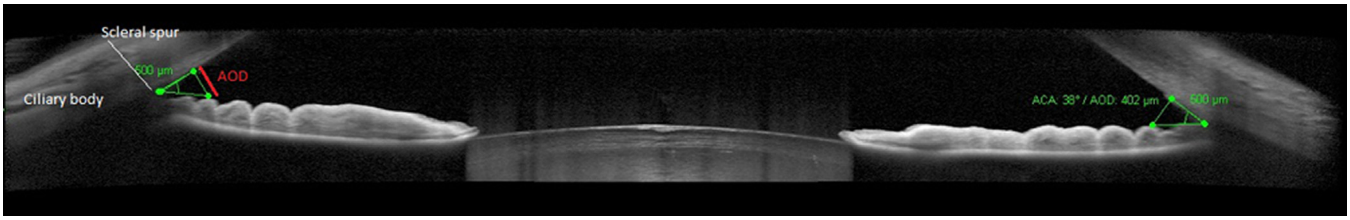

Fig. 1. Nasal and temporal angle opening distance at 500 μm anterior to the scleral spur (AOD_{500}).

In this study, the aim was to evaluate the dark–light changes of the ACA in Iranian subjects with angle closure glaucoma using the SAS-OCT.

2. Methods

This was a prospective observational study included the patients came to glaucoma clinic of the Razavi hospital, Mashhad, Iran. The study was approved by human ethics committee in Razavi hospital and followed the recommendation of the Declaration of Helsinki 2008 for ethical standards. The informed consent was obtained from all the participants after the brief explanation of the study's procedures.

All the subjects underwent a comprehensive ophthalmic examination including: taking history, best corrected visual acuity (Snellen E chart and Topcon RM-8800, Topcon Corporation, Tokyo, Japan), slit lamp biomicroscopy, intraocular pressure measurement with Goldmann tonometer, and fundus examination with 75 Diopter lens (Volk Optical Inc., Mentor, OH, USA). All the measurements were done during 10–12 am to eliminate the diurnal variations.

Gonioscopy was performed by the use of Sussman goniolens in a dark room and the angle was classified according to the Shaffer grading system. The eye was grouped as open (normal) if the angle Shaffer grade was 3 or 4 in a dark condition. On the other hand, an eye with angle Shaffer grade 2 or 1 was categorized as a narrow angle. As the aim of this study was to assess the dark–light changes of the ACA, we focused only on the nasal and temporal angles for the analysis.

The exclusion criteria were the use of medication with an effect on the drainage of the angle, history of trauma or ocular surgery, laser treatments (trabeculoplasty, laser iridotomy, laser iridoplasty), peripheral anterior synechiae and plateau iris. The open angle subjects were free of ocular eye disease. Only one eye of each subject was included and used in analysis even if both eyes fulfilled the inclusion criteria.

2.1. *Spectralis anterior segment optical coherence tomography imaging*

Imaging with Spectralis Anterior Segment Optical Coherence Tomography (Heidelberg Engineering, Heidelberg, Germany) was performed for all participants in the dark and light conditions. This optical instrument was used to measure the ACA and angle opening distance (AOD). For OCT measurement, subjects were asked to sit in the position and fixate on an internal target. They were first dark adapted (20 lux) for about 1 min and the angle was imaged. Then the light with intensity of 368 lux was turned on to measure the angle under this condition. The scans were centered on the pupil and both nasal and temporal angle were imaged along the horizontal meridian (3 and 9 o'clock meridians). A single observer took 3 scans from each eye before gonioscopic examination. For the further analysis, only the image with higher quality and visibility of the angle structure in each quadrant was used. We only accepted images with clearly visible scleral spurs.

2.2. *Measurement of AOD*

The AOD500 (Fig. 1) was defined as the distance from the corneal endothelium to the anterior iris perpendicular to a line drawn at 500 μm from the sclera spur. The SAS-OCT is equipped with a program that provides measurement of AOD at 500, 750 μm or any distance from the sclera spur. The operator needs to enter the location of the sclera spur and then the program automatically calculated the AOD. High repeatability of this instrument was previously indicated in assessment of anterior chamber angle [8,9].

The following parameters were recorded for further analysis: temporal and nasal ACA in dark condition, temporal and nasal ACA in light condition, temporal and nasal AOD500 in dark condition, temporal and nasal AOD500 in light condition, intraocular pressure (IOP) and spherical equivalent (SE). In the present study, both the temporal and nasal angles were evaluated to determine the changes of the ACA and AOD500 in 2 conditions and to assess whether the patterns of changes in response to illumination is different in the mentioned quadrants.

2.3. *Statistical analysis*

SPSS software version 18.0 was used for statistical analysis. Mann–Whitney test was performed to compare the studied parameters (age, IOP, SE and dark-room gonioscopy grading) between the normal and narrow angle groups and Wilcoxon signed-rank test was employed to examine the difference between the dark and light conditions. To assess the correlation of the factors including age, IOP, SE and dark-room gonioscopy grading with AOD difference (AOD500(light)_AOD500 (dark)) and also with ACA difference (ACA(light)_ACA(dark)), the Spearman correlation test was done. This test was also used to evaluate the relationship between AOD500 and pupil diameter. The $p < 0.05$ was considered statistically significant.

3. Results

This study included 84 narrow angle and 26 open angle subjects. The mean age was 51.96 ± 11.16 years in normal subjects (29 male and 55 female) and 58.47 ± 9.40 years in narrow angle group (12 male and 14 female). Table 1 indicates the mean and standard deviation (SD) of the studied parameters in 2 groups of subjects. Two groups were sex ($p = 0.07$) matched.

All the parameters were significantly lower in narrow angle group ($p < 0.05$) except IOP and SE that were statistically higher in this group ($p < 0.05$). In both groups, ACA and AOD500 in both nasal and temporal quadrants were significantly greater in the light compared to the dark (all with $p = 0.000$). The AOD500 and ACA were significantly higher in the nasal than the temporal quadrant in both light and dark conditions in 2 groups except the ACA and AOD500 of normal group measured in the light (Table 2). The difference between nasal and temporal in the dark (29.07 ± 65.71 μm for AOD500 and 5.7 ± 4.07° for ACA) was greater than the light (24.86 ± 79.85 μm for AOD500 and 2.09 ± 7.21° for ACA) condition.