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Original research

Qualitative evaluation of anterior segment in angle closure disease using anterior segment optical coherence tomography

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Abstract

Purpose: To evaluate different mechanisms of primary angle closure (PAC) and to quantify anterior chamber (AC) parameters in different subtypes of angle closure disease using anterior segment optical coherence tomography (AS-OCT).
Methods: In this prospective study, 115 eyes of 115 patients with angle closure disease were included and categorized into three groups: 1) fellow eyes of acute angle closure (AAC; 40 eyes); 2) primary angle closure glaucoma (PACG; 39 eyes); and 3) primary angle closure suspect (PACS; 36 eyes). Complete ophthalmic examination including gonioscopy, A-scan biometry, and AS-OCT were performed. Based on the AS-OCT images, 4 mechanisms of PAC including pupillary block, plateau iris configuration, thick peripheral iris roll (PIR), and exaggerated lens vault were evaluated. Other angle, anterior chamber, and lens parameter variables were also evaluated among the three subtypes.
Results: There was a statistically significant difference in the mechanism of angle closure among the three groups ($p = 0.03$). While the majority of fellow eyes of AAC and of PACS eyes had pupillary block mechanism (77.5% and 75%, respectively), only 48.7% of PACG eyes had dominant pupillary block mechanism ($p = 0.03$). The percentage of exaggerated lens vault and plateau iris mechanisms was higher in PACG eyes (25.5% and 15.4%, respectively). Fellow eyes of AAC had the shallowest AC ($p = 0.01$), greater iris curvature ($p = 0.01$), and lens vault ($p = 0.02$) than PACS and PACG eyes. Iris thickness was not significantly different among the three groups ($p = 0.45$).
Conclusion: Using AS-OCT, we found that there was a statistically significant difference in the underlying PAC mechanisms and quantitative AC parameters among the three subtypes of angle closure disease.

Keywords: Anterior segment optical coherence tomography; Angle closure; Glaucoma; Lens vault; Iris curvature

Introduction

Primary angle closure glaucoma is a major cause of blindness worldwide, accounting for bilateral blindness in more than almost 5.3 million people by 2020.[1] Although pupillary block and plateau iris syndrome have been proposed as the two main mechanisms in the pathogenesis of angle closure disease, other anatomical factors related to the iris, lens, and ciliary body have also been shown to play important roles.[2–5] Established ocular biometric factors associated with angle closure disease include a shorter axial length (AL), shallower anterior chamber (AC), thicker peripheral iris, and a thicker, more anteriorly positioned lens.[5–10]

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With the development of anterior segment optical coherence tomography (AS-OCT), researchers can capture and visualize the entire anterior segment in a single image and assess angle, iris, and lens parameters. Anterior segment OCT–based parameters, such as lens vault, anterior chamber area, anterior chamber width, and iris thickness have been associated with angle closure.[11–13] Iris curvature has been proposed to be an indicator of pupillary block.[4,14–16] As iris curvature is reported to be only moderately correlated with increased lens vault, pupillary block may not be the only mechanism by which increased lens vault causes angle closure.[10,14] In fact, there are some cases with exaggerated lens vault in which the iris appears to drape the anterior surface of the lens, giving rise to a "volcano-like configuration" without an increase in iris curvature.[3,17,18]

Shabana et al[3] evaluated four different mechanisms of primary angle closure (PAC) using AS-OCT. In their new classification, AS-OCT images were categorized into four mechanisms including pupillary block, plateau iris configuration, thick peripheral iris roll (PIR), and exaggerated lens vault.

Angle closure disease is classified into different subtypes including primary angle closure suspect (PACS), acute angle closure (AAC), and primary angle closure glaucoma (PACG).[17,19,20] Qualitative and quantitative evaluation of the anterior segment in these eyes might be helpful in explaining the pathogenesis of angle closure. Understanding these mechanisms may explain why some of these eyes develop acute angle closure while others lead to chronic disease. Our previous studies have shown that exaggerated lens vault is one of the main mechanisms in eyes with acute angle closure during attack. In this study, different subtypes of angle closure disease including fellow eyes of AAC, PACG, and PACS were evaluated.

Methods

Patients

In this cross-sectional study, between Sep 2011 and Sep 2013, 154 eyes (154 patients) with at least one eye with acute angle closure, primary angle closure suspect status, and primary angle closure glaucoma, as defined below, were consecutively recruited from the Glaucoma Clinic, a tertiary care center of the Farabi Eye Hospital, prior to a laser iridotomy. The Ethics Committee at Farabi Eye Hospital approved the study protocol. All patients provided written informed consent forms in accordance with the Declaration of Helsinki. Only the right eyes of patients were included for analysis in this study. If the left eye was the only affected one, the left eye was included. Eyes with a history of pilocarpine usage, trauma, uveitis, ocular laser, and/or surgical procedures (e.g., laser peripheral iridotomy; LPI) were excluded. Additionally, we excluded eyes with pseudoexfoliation (PEX), iris or angle neovascularization, any kind of secondary angle closure, or any iris or corneal abnormalities. None of the patients had taken any miotic or mydriatic medications.

After excluding eyes with poor AS-OCT image quality (28 eyes), PEX (4 eyes), prior LPI (3 eyes), and secondary angle closure (2 eyes), a total of 115 eyes (115 patients) were classified into one of the following three groups:

1) The fellow eye of AAC (40 eyes). AAC was defined as: a) at least two of the symptoms of an acute episode of intraocular pressure (IOP) rise which are ocular pain or headache, nausea and/or vomiting, decreased vision, and rainbow-colored halos around lights; b) IOP at presentation of at least 30 mmHg with Goldmann applanation tonometry; c) examination findings such as conjunctival injection, corneal epithelial edema, fixed mid-dilated pupil, and shallow AC; and d) shallow AC and narrow angle in the other eye.
2) PACG eyes (39 eyes) had chronically elevated IOP above 21 mmHg (prior to treatment) along with glaucomatous optic neuropathy and characteristic visual field defects, shallow AC, and iridotrabecular contact (ITC) in at least 3 quadrants on gonioscopy along with a variable amount of peripheral anterior synechiae (PAS).
3) PACS eyes (36 eyes) were classified based on the posterior trabecular meshwork not being visible in at least 3 quadrants without PAS or any evidence of glaucomatous optic nerve or visual field damage. These patients did not have any history or sign of previous AAC attack, and IOP was $\leq$21 mmHg without medication.

Exams

Slit lamp examination of the anterior segment, Goldmann applanation tonometry, and gonioscopy in dark conditions (with and without indentation) were conducted in all patients. Indentation gonioscopy was performed by a glaucoma specialist (S.M.) using a Zeiss-style four-mirror goniolens (Model G-4, Volk Optical, Mentor, OH), and the angles were graded using Shaffer system. A-scan biometry (Echoscan, model U3300, Nidek, Tokyo, Japan) was used to measure axial length (AL), lens thickness (LT), and anterior chamber depth (ACD).

All subjects underwent static automated white-on-white threshold perimetry (program 24-2, Swedish Interactive Threshold Algorithm standard, model 750, Humphrey Field Analyzer, Humphrey Instruments, Dublin, CA).

Anterior segment optical coherence tomography

AS-OCT (Visante OCT; Carl Zeiss Meditec, Dublin, CA) was performed for all the patients in the dark. Scans were centered on the pupil and were obtained along the horizontal and vertical axes using the enhanced anterior segment single protocol. Two images were captured for each axis, and the one with higher quality was chosen for analysis. Detection of the scleral spurs was optimized by adjusting the brightness and contrast of each image. Two experienced ophthalmologists (S.M., N.H.) determined the location of the scleral spur

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