

Gonioscopic Features in Patients with Acute and Chronic Angle-Closure Glaucoma

Original Article

Mohammad Reza Razeghinejad

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Department of Ophthalmology,
Medical School,
Shiraz University of Medical Sciences,
Shiraz, Iran.

Correspondence:

Mohammad Reza Razeghinejad MD,
Department of Ophthalmology
Khalili Hospital
Shiraz University of Medical Sciences,
Shiraz, Iran.

Tel/Fax: +98 711 6471479

Email: razeghinejad@yahoo.com
mrazeghi@sums.ac.ir

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Abstract

Background: A number of ocular biometric parameters, iris histologic and anatomic characters have been suggested as inciting factors for converting patients with narrow angle to angle-closure glaucoma. This study was conducted to determine if there was any gonioscopic difference between patients with acute angle-closure glaucoma (AACG) and chronic angle-closure glaucoma (CACG).

Methods: The study is a retrospective analysis of the charts of 97 patients with asymmetric CACG and 15 patients with unilateral AACG. The age, sex, type of glaucoma, gonioscopic findings and optic nerve head cup/disc ratio were recorded for all patients. Dynamic gonioscopy and Spaeth's convention were used to grade the drainage angle. The eyes with AACG or more optic nerve damage in CACG groups were considered as involved eye, and the contralateral eyes in the AACG and CACG groups were considered as noninvolved and less-involved, respectively.

Results: There was no significant difference between patients with AACG and CACG in terms of age, gender, refraction, and laterality of the involved eyes. In intragroup analysis, no significant difference was observed for distribution of iris attachment, irido-corneal angle, iris configuration, or trabecular pigmentation. In intergroup analysis, the superior iris was attached more anterior in the involved eyes of AACG compared to that in CACG ($P=0.007$). Moreover, the iris root attachment was also more anterior in both the superior ($P=0.001$) and inferior ($P=0.002$) angles of the noninvolved eyes of AACG vs. than those in the less-involved eyes of CACG group.

Conclusion: The findings of the study indicate that there is no significant difference between the eyes with AACG or CACG in terms of gonioscopic findings. However, the superior iris attachment was located more anterior in eyes with AACG compared to that in eyes with CACG.

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Keywords • Angle-closure glaucoma • gonioscopy • iris

Introduction

Primary angle-closure glaucoma (PACG) is a leading cause of blindness, particularly in Asia.¹ It is estimated that 26% of 80 million glaucomatous patients will have PACG by 2020.¹ The primary angle-closure glaucoma is considered the most

widespread type of glaucoma in people with Asian origin.² The risk of visual impairment and blindness is higher in PACG than in primary open-angle glaucoma. It is estimated that PACG blinds five times more people than primary open-angle glaucoma in absolute terms.³ Therefore, early detection and treatment are important in the prevention of blindness from PACG.

A significant percentage of the population (10.35%) has been reported to have narrow irido-corneal angles.⁴ Population-based data suggest that only a small proportion of subjects with gonioscopically narrow angles ultimately develop PACG.⁵⁻⁶ Prophylactic laser iridotomy is available to avoid acute episodes in predisposed eyes. A laser peripheral iridotomy flattens the convex iris and widens the angle.⁷

Primary angle-closure glaucoma is classified as acute, subacute, and chronic forms. Factors which contribute to the conversion of narrow irido-corneal angles to any of the three above-mentioned types are not determined yet. It would be of interest to know why some patients with narrow angle develop acute and others develop chronic angle-closure glaucoma. Several studies have shown a difference in biometric parameters of the eyes with acute angle-closure glaucoma (AACG) eyes compared to those of chronic angle-closure glaucoma (CACG).⁸⁻¹⁰ He and colleagues stated that contrary to iris in eyes with CACG, the iris of the eyes with AACG had a higher density of collagen type I fibers.¹¹ This histological change may result in the loss of iris elasticity, and probably less resistance to forward bowing of the iris in some PACS eyes may predispose them to an acute attack. Recently Aptel and Denis,¹² showed that in narrow-angle eyes the iris volume increased after pupil dilation, which predisposes the eyes to AACG. All methods employed in the above-mentioned studies are dependent on imaging or laboratory devices.⁶⁻¹⁰ The aim of this study was to employ gonioscopy, as an inexpensive and available method, to determine any possible characteristic gonioscopic finding, which may predispose patients with narrow irido-corneal angle to angle-

closure glaucoma.

Materials and Methods

The study is a retrospective analysis of the charts of patients, who were diagnosed as having unilateral AACG or asymmetric CACG from 2002 to 2009. The eyes with AACG and those with more optic nerve damage in CACG groups were considered as involved eyes, and the contralateral eyes in AACG and CACG were considered as noninvolved and less-involved eyes, respectively. The asymmetry of CACG was defined as a difference of 0.2 in cup/disc ratio between involved and less-involved eyes. Laser iridotomy had been performed in patients with AACG after controlling the intraocular pressure (IOP); however, only those who had pre-laser gonioscopic findings were included in the study. Patients with previous laser iridotomy or laser iridoplasty, previous ocular or glaucoma surgery, history of trauma, or secondary angle closure glaucoma (neovascularization, uveitis) were excluded.

Acute angle-closure glaucoma had been diagnosed in eyes with high IOP, a gonioscopically closed angle, and acute symptoms such as ocular pain, redness and blurred vision. Chronic ACG had been diagnosed in eyes with a closed angle associated with elevated IOP and changes to the optic disc or visual field.¹³

The age, gender, type of glaucoma, gonioscopic findings and optic nerve head cup/disc ratio were recorded for all patients. The employed method for gonioscopy was dynamic gonioscopy using Spaeth's convention to grade the drainage angle. Spaeth's gonioscopic grading relies on three separate descriptors of the anterior chamber angle's anatomy, including the iris insertion, angular approach of the iris, and peripheral iris contour (table 1). In the case of iris insertion, the point of presenting contact between the iris and the posterior surface of the corneoscleral coat before indentation was recorded as the "apparent" iris insertion, whereas the point of contact identified during dynamic examination was recorded as the "true" iris insertion. The apparent iris inser-

Table 1: Spaeth's gonioscopic grading.

| Iris insertion | Irido-corneal angle | Iris configuration | Pigmentation of trabecular meshwork |
|--|---------------------|--------------------|-------------------------------------|
| A: Anterior to schwalbe's Line | 0° to 45° | r+: regular | +6+ |
| B: Between Schwalbe's line and scleral spur | | s: steep | 1+minimal |
| C Scleral spur visible | | q: queer | 2+mild |
| D: Deep with ciliary body visible | | | 3+moderate |
| E: Extremely deep with >1 mm of ciliary body Visible | | | 4+intense |

tions were shown in a parenthesis and the true iris insertion after the parenthesis. In those that the apparent and true iris insertions were similar only the appropriate letter was mentioned.¹⁴

The entire angle width was divided into 4 sectors as superior, inferior, nasal and temporal. To simplify the result only the findings of superior and inferior quadrants were included and analyzed.

Statistical Analyses

Statistical analyses were performed using the independent sample *t*-test for the evaluation of intergroup continuous variables (shown as mean±standard deviation) and the Chi-Square test for comparing of the categorical data. A *P* value of ≤0.05 was considered statistically significant for all analyses. Statistical Package for Social Sciences (SPSS version 11.5) was used for performing statistical analysis.

Results

The chart of a total of 112 patients, 97 with CACG and 15 with AACG, were included in the study. There were no significant differences between patients with AACG and CACG in terms of age (*P*=0.4) or gender (*P*=0.5). There were 6 males and 9 females with AACG, and 32 males and 65 females with CACG. The age of AACG patients was 67.5±14.2 years, and that of CACG patients was 69.9±12.5 years (*P*=0.4). Five out of 15 involved eyes in the AACG and 48 out of 97 eyes in the CACG were right eyes (*P*=0.2).

The manifest refraction in the involved eyes was 2.1±1.4 diopters in the AACG patients and that in the noninvolved eyes was 2.6±0.7 diopters (*P*=0.4). In the CACG group, these figures were 2.02±2.4 diopters and 2.1±2.3 diopters, in the involved and less-involved eyes, respectively (*P*=0.4). There was no statistically significant difference between the cup/disc ratio of the involved (4.2±2.4) and noninvolved eyes (3.5±2) eyes in the AACG group (*P*=0.5). The amount of optic nerve head cupping in the involved eyes (5.6±2.5) of patients with CACG patients were significantly (*P*<0.0001) greater than that of less-involved eyes (4.2±2.2).

In intragroup analysis, no significant difference was observed for the distribution of iris attachment (table 2), irido-corneal angle (table 3), or iris configuration and trabecular pigmentation (table 4). In intergroup analysis (table 5), there was significant difference between involved eyes of AACG and CACG for superior iris attachment (*P*=0.007). The most common pattern of superior iris attachment in the involved eyes of AACG group were "A" (40%) and "(A) D" (21.7%) in the CACG. This difference was not significant for inferior iris attachment (*P*=0.09). The most common feature for inferior iris attachment in the involved eyes of AACG was (A) C or (A) D with a frequency of 13.3%, and of the CACG was (A) D with a frequency of 21.6%.

There were significant (*P*=0.001) differences between the superior iris attachments of the noninvolved eyes of the AACG and less-involved eyes of the CACG. Moreover, a

Table 2: Distribution of iris attachment in the patients with acute or chronic angle closure glaucoma

| | AACG | | P value | CACG | | P Value |
|--------------------------|----------|------------|---------|-----------|---------------|---------|
| | Involved | Uninvolved | | Involved | Less-involved | |
| Superior iris attachment | | | | | | |
| (A)B [†] | 1(10%) | 1(6.6%) | 0.7 | 6(7.2%) | 7(7.2%) | 0.7 |
| (A)C | 2(20%) | 6(33.3%) | | 8(9.6%) | 7(7.2%) | |
| (A)D | 2(20%) | 1(6.6%) | | 18(21.7%) | 22(22.9%) | |
| (B)C | 1(10%) | 1(6.6%) | | 17(20.5%) | 16(16.7%) | |
| (B)D | | | | 13(15.7%) | 13(13.56%) | |
| A | 4(40%) | 4(26.6%) | | 3(3.7%) | 8(8.3%) | |
| B | | | | 2(2.4%) | 1(1.04%) | |
| C | | 1(6.6%) | | 15(18%) | 21(21.8%) | |
| D | | 1(6.6%) | | 1(1.2%) | | |
| Inferior iris attachment | | | | | | |
| (A)B | 2(13.3%) | 1(6.7%) | 0.3 | 5(6.7%) | 5(6.09%) | 0.9 |
| (A)C | 2(13.3%) | 7(46.7%) | | 4(5.4%) | 7(8.5%) | |
| (A)D | 1(6.7%) | 1(6.7%) | | 16(21.6%) | 19(23.1%) | |
| (B)C | 1(6.7%) | | | 15(20.2%) | 19(23.1%) | |
| (B)D | 3(20%) | 1(6.7%) | | 13(17.5%) | 10(12.1%) | |
| A | | 1(6.7%) | | 4(5.4%) | 2(2.4%) | |
| B | | | | 3(4.05%) | 2(2.4%) | |
| C | | 1(6.7%) | | 13(17.5%) | 17(20.7%) | |
| D | | 1(6.7%) | | 1(1.3%) | 1(1.2%) | |

[†] The apparent iris root insertions are shown in the parenthesis and the true insertions (indentation gonioscopy) are following the parenthesis. A: anterior to schwalbe's Line; B: between Schwalbe's line and scleral spur; C: scleral spur visible; D: deep with ciliary body visible; E: extremely deep with >1 mm of ciliary body visible.

Table 3: Irido-corneal angle in patients with acute or chronic angle closure glaucoma.

| | AACG | | P value | CACG | | P value |
|------------------------|----------|------------|---------|-----------|---------------|---------|
| | Involved | Uninvolved | | Involved | Less-involved | |
| Superior angle(degree) | | | | | | |
| 0 | | | | 1(1.1%) | 1(1.04%) | 0.7 |
| 5 | 2(20%) | 5(33.3%) | 0.4 | 14(16.4%) | 14(14.5%) | |
| 10 | 6(60%) | 5(33.3%) | | 41(48.2%) | 44(45.8%) | |
| 15 | 2(20%) | 3(20%) | | 14(16.4%) | 24(25%) | |
| 20 | | | | 12(14.1%) | 12(12.5%) | |
| 25 | | 2(13.3%) | | 3(7.05%) | 1(1.04%) | |
| Inferior angle(degree) | | | | | | |
| 0 | | | | | 1(1.2%) | 0.8 |
| 5 | 2(22.2%) | 4(30.8%) | 0.5 | 12(16.2%) | 9(10.9%) | |
| 10 | 5(55.5%) | 4(30.8%) | | 28(33.7%) | 34(41.4%) | |
| 15 | 2(22.2%) | 3(23%) | | 19(25.6%) | 20(24.3%) | |
| 20 | | | | 11(14.8%) | 15(18.2%) | |
| 25 | | 2(15.4%) | | 4(5.4%) | 3(3.6%) | |

Table 4: Iris configuration and trabecular meshwork pigmentation in patients with acute or chronic angle closure glaucoma

| | AACG | | P value | CACG | | P value |
|----------------------------------|----------|------------|---------|-----------|---------------|---------|
| | Involved | Uninvolved | | Involved | Less-involved | |
| Superior iris configuration | | | | | | |
| r [†] | 7(70%) | 14(93.3%) | 0.1 | 70(85.3%) | 83(86.4%) | 0.9 |
| s | 3(30%) | 1(6.7%) | | 11(13.4%) | 12(12.5%) | |
| q | | | | 19(1.3%) | 1(1.1%) | |
| Inferior iris configuration | | | | | | |
| r | 7(77.8%) | 13(100%) | 0.07 | 60(83.3%) | 68(82.9%) | 0.9 |
| s | 2(22.2%) | | | 10(13.9%) | 12(14.6%) | |
| q | | | | 2(2.8%) | 2(2.5%) | |
| Trabecular meshwork pigmentation | | | | | | |
| +1 | 5(33%) | 5(33%) | 0.7 | 23(42.6%) | 27(44.4%) | 0.9 |
| +2 | 3(20%) | 3(20%) | | 26(48.2%) | 28(45.9%) | |
| +3 | 1(6.7%) | 1(6.7%) | | 4(7.4%) | 5(8.1%) | |
| +4 | | | | 1(1.8%) | 1(1.6%) | |

[†]r: regular. s: steep, q: queer.

Table 5: The P values of comparisons of gonioscopic characters in the involved and noninvolved eyes of patients with acute angle-closure glaucoma (AACG), and involved and less-involved eyes of patients with chronic angle closure glaucoma (CACG).

| | AACG | CACG |
|----------------------------------|---------------------------|----------------------------|
| | Involved vs. non involved | Involved vs. Less-involved |
| Superior iris attachment | 0.007 | 0.001 |
| Superior irido-corneal angle | 0.8 | 0.03 |
| Superior iris configuration | 0.3 | 0.7 |
| Inferior iris attachment | 0.09 | 0.002 |
| Inferior irido-corneal angle | 0.6 | 0.13 |
| Inferior iris configuration | 0.7 | 0.2 |
| Trabecular meshwork pigmentation | 0.8 | 0.3 |

significant difference ($P=0.002$) was found between the iris attachments of the noninvolved eyes of the AACG and less-involved eyes of the CACG. The most common pattern of superior iris attachments in the uninvolved eyes of AACG was "(A) C" with a frequency of 33.3%. However, the most common pattern of superior iris attachments in the less-involved eyes of CACG was "(A) D" with a frequency of 22.9%. Sixty percent of involved eyes in the AACG group and 48.2% of such eyes in the CACG group had an irido-corneal angle 10 degrees in the superior quadrants. These values for the inferior angle of involved eyes were 55.5% and 33.4%, respectively. The most common pattern of iris configuration in both groups was "r".

Discussion

Pupil block is believed to be the major causative mechanism in angle closure glaucoma. Pupillary block develops in eyes that are anatomically predisposed when the proximity between the posterior surface of iris and lens generates an increase in aqueous flow resistance from posterior chamber to the anterior chamber, thus forcing the iris to bow anteriorly which occludes the irido-corneal angle and clogs the aqueous egress through trabecular meshwork.¹⁵ A large number of eyes with the features of narrow angles do not develop any clinically meaningful signs of angle closure damage even over a long period of time.

The risk factors for PACG have been previously studied, and include a shallow anterior chamber depth and other ocular biometric characteristics such as short axial length, and thick and anteriorly placed lens.^{8,16,17} A cross sectional study in Singapore investigated the determinants of angle closure, and demonstrated that the strongest predictors for the disease were female gender, shorter axial length, shallower anterior chamber depth, and Chinese race/ethnicity.¹⁸

Identifying ocular characters that are associated with angle closure are important for understanding the mechanisms of the disease, for designing cost effective population-based screening strategies, and for determining the patients who may benefit from prophylactic laser iridotomies. Various studies on the histology of iris,¹¹ iris parameters,¹⁹ and anterior chamber width,²⁰ have been performed, and as yet no definite factor has been determined as a certain factor for inducing glaucoma in predisposed individuals. In a study, using ultrasound biomicroscope to assess the angle response to changes in illumination, the authors hypothesized that a less stable iris root predisposes the peripheral iris to move closer to the trabecular meshwork in some angle closure glaucoma patients.²¹ There was no significant difference between the gonioscopic findings of the involved and uninvolved eyes in AACG or involved and less-involved eyes in CACG groups in the present study. The superior iris root attachment was located more anterior in the AACG compared to CACG groups in both the involved vs. involved ($P=0.007$) and uninvolved vs. less-involved eyes ($P=0.001$). Although there was no significant difference for the inferior iris attachment of the involved eyes between AACG and CACG groups ($P=0.09$), the inferior iris in the less-involved eyes of AACG group were attached more anterior ($P=0.002$). Such a finding of the present study is consistent with that of Yao and coworkers,²² who investigated the frequency of appositional angle closure and related anatomic characteristics in fellow eyes of patients with AACG after performing laser peripheral iridotomy using ultrasound biomicroscope. In a study of 34 fellow eyes of 34 patients with AACG, more than one third showed appositional angle closure.¹⁵ The authors stated that a narrower angle, a more anterior position of the ciliary body, and a thicker peripheral iris in fellow eyes of AACG after prophylactic laser iridotomy might be associated with an increased risk for progressive angle closure.

The frequency of narrower angle in the

superior quadrants in patients with AACG was greater than those in patients with CACG, though not statistically significant. This supports previous findings that angle width was narrowest in the superior quadrant.²³ This variation in angle width by quadrant has been postulated to be an artifact that is due to gravitational forces in the sitting position and to indentation of the superior cornea by the upper eyelid.²⁴ The least irido-corneal angle observed in superior quadrant of the involved eyes of AACG was 5 degree. The findings suggest that the development of an AACG attack might be associated with specific anatomic structure of the angle. However, it is highly likely that there are other yet unidentified factors that convert narrow angles to AACG or CACG.

Patients in the AACG group had commonly 1+ trabecular pigmentation and in those of CACG group 2+ pigmentation were the most frequent patterns. This can be explained by the possibility of more apposition between iris and trabecular meshwork in the CACG.

The findings of the present study should be interpreted in the light of a number of limitations. The sample size in the AACG group was small, consisting of only 15 eligible patients. However, given the decline in the prevalence of AACG, performing a study on a larger group of patients seems impractical. Moreover, due to prophylactic laser iridotomy in susceptible patients and timely cataract surgery, which decreases the proportion of people with thick lenses in the population, recruiting patients with AACG before any intraocular procedure in any study is not easy. However, based on a PubMed search, this is the first study to characterize and compare characteristic gonioscopic anatomical features in patients with AACG and CACG. Additionally, performing gonioscopy by more than one examiner can be regarded as another limiting factor, which is one of the most common ones in all retrospective studies.

The imaging techniques are not likely to be sufficiently rapid or robust for use in large scale screening, and may not be available in developing countries, which have a shortage of budget. At the opposite extreme of technologic complexity, an oblique, hand-held flashlight,²⁵ and a peripherally aimed slit-lamp beam (Van Herick technique),²⁶ have both been suggested as simple and rapid techniques for estimating the configuration of the peripheral anterior chamber. Although these techniques are technologically appropriate for use in the developing world, it does not appear likely that either of these techniques will provide an acceptable

degree of repeatability and diagnostic precision. In contrast, it has been shown that dynamic gonioscopy and Spath's gonioscopic grading have good correlation with various imaging machines.^{27,28}

Conclusion

The findings of the present study demonstrate the possible difference in angle topology between AACG and CACG. However, the findings can not fully explain the process of an acute AACG or CACG. Further studies are needed to determine how the narrow angles lead to AACG or CACG. It is hoped that a better understanding of the anatomic factors underlying PACG may lead to better screening, more effective treatment, and performing on-time prophylactic laser iridotomy for this relatively common blinding condition.

Conflict of Interest: None declared

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