Eye (2005) 19, 990–994

www.nature.com/eye

CLINICAL STUDY

Usefulness of peripheral anterior chamber depth assessment in glaucoma screening

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Abstract

Purpose **This study was conducted to determine the usefulness of peripheral anterior chamber depth assessment in angle-closure glaucoma (ACG) screening in Japanese subjects.**

Subjects and methods **The subjects were 14 779 adults 40 years old or older. Eyes having peripheral anterior chamber depth that is 1/4 the peripheral corneal thickness (van Herick's classification: grade 2) and less than 1/4 the peripheral corneal thickness (van Herick's classification: grade 1) were extracted as narrow angle eyes, and those eyes were further examined.**

Results **Of 14 779 subjects, 923 eyes of 505 subjects were diagnosed as narrow angle eyes (3.4%). Narrow angle eyes were observed in 4.9% of female subjects and 1.9% of male subjects, indicating a significantly higher frequency in women. The percentage of narrow angle eyes increased with age. Among the narrow angle eyes, 61 eyes of 32 subjects were diagnosed with ACG suspect (6.5%). In contrast to the frequency of ACG suspect in eyes classified as grade 1, according to van Herick's classification, being 17.9%, that in eyes classified as grade 2 was significantly lower at 5.6%.**

Conclusion **Since the incidence of ACG suspect increases as the peripheral anterior chamber depth decreases, caution for the peripheral anterior chamber depth is required for the ACG screening.**

Eye (2005) **19,** 990–994 doi:10.1038/sj.eye.6701700; published online 1 October 2004

Keywords: peripheral anterior chamber depth; angle-closure glaucoma; van Herick classification; Japanese; survey

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Received: 20 April 2004 Accepted: 13 July 2004 Published online: 1 October 2004

Proprietary interest: none

Introduction

The frequency of primary angle-closure glaucoma (PACG) has been reported to be particularly high in Asian countries.[1–3] In Japan, a previous epidemiological survey has shown that 0.34% of persons 40 years old or older have PACG,[4] but a recent epidemiological survey shows that frequency of PACG is 1.12% of persons 40 years old or older (unpublished data). In the case of PACG, once an attack occurs, serious impairment of visual function may occur within a short period of time; however, differing from open-angle glaucoma (OAG), the angle-closure glaucoma (ACG) attack can be prevented in many cases by peripheral iridectomy or peripheral laser iridotomy. Thus, it is important to perform prophylactic treatment prior to the occurrence of a glaucoma attack. Studies have been conducted regarding the manner by which patients who are at risk of the occurrence of ACG can be detected. Although the central anterior chamber depth has been reported to be useful in the detection of ACG eyes,[5] it is difficult to use ultrasonic devices in the screening because the test using those devices cannot be performed without touching the cornea. Although gonioscopy is considered to be the most effective diagnostic method, it is subjective and cannot be performed without touching the cornea, and considerable skill and experience are required in making an assessment. Thus, these methods are not suitable for glaucoma screening. A method for detecting ACG eyes based on peripheral anterior chamber depth has been advocated by van Herick.[6] However, the usefulness of van Herick's classification for detecting ACG is controversial. Foster *et al*[1] has reported its usefulness, but Congdon *et al*[7] have reported that van Herick's classification had low

sensitivity and specificity to detect patients with ACG. Many of those reports describe findings obtained from a relatively small number of eyes, and there are few reports describing their usefulness in Japanese subjects. In this study, a large-scale ophthalmic epidemiological survey was conducted in Japan to assess peripheral anterior chamber depth in 14 779 subjects aged 40 years or over based on van Herick's classification. The results were analysed to assess the relationship between peripheral anterior chamber depth and the incidence of glaucoma as well as factors that may have an influence on peripheral anterior chamber depth.

Subjects and methods

This study was conducted in accordance with the Helsinki treaty and were approved by the committee of the Japan Glaucoma Society and Tajimi city. All of the residents of the city of Tajimi in Gifu Prefecture as of 1 April 2001 were recruited to attend an ophthalmic epidemiological survey. Of all the above residents, 4000 subjects were randomly selected for a glaucoma epidemiological survey for estimating the frequency of glaucoma and the rest of residents were subjected to an ophthalmic epidemiological survey. In this paper, all analyses were conducted using data from subjects attending an ophthalmic epidemiological survey. Of 50 165 subjects, 14 779 subjects had undergone an ophthalmic epidemiological survey. After obtaining written informed consent from all the subjects, physical examination (diagnosis and interview), refraction examination, intraocular pressure (IOP) examination using Goldmann's applanation tonometer, slit-lamp examination, and photography of the optic disc using a nonmydriatic camera (Topcon, Imagenet 6S, Topcon, Tokyo, Japan) were performed.

Peripheral anterior chamber depth was classified into one of four grades by experienced ophthalmologists according to the report of van Herick.[6] Eyes having a peripheral anterior chamber depth of 1 or more of the peripheral corneal thickness were classified as grade 4, those having a peripheral anterior chamber depth of 1/2–1/4 the peripheral corneal thickness were classified as grade 3, those having a peripheral anterior chamber depth of 1/4 the peripheral corneal thickness were classified as grade 2, and those having a peripheral anterior chamber depth of less than 1/4 the peripheral corneal thickness were classified as grade 1. Only the eyes that were classified as grade 1 or 2 according to van Herick's classification were extracted as narrow angle eyes. Narrow eyes satisfying more than one of the following were diagnosed as those with ACG suspect: having a glaucomatous cupping of the optic nerve with peripheral anterior synechia and/or appositional angle closure, IOP of 22 mmHg or higher with peripheral anterior synechia and/or appositional angle closure, and having a history of well-defined glaucoma attacks and clear signs of a history of glaucoma attacks, for example, demonstrating a history of well-defined glaucoma attacks and exhibiting iris atrophy or paralytic mydriasis in slit-lamp examinations. Assessment of the optic disc was performed by one glaucoma specialist (TY).

Statistical analysis

For statistical analysis, the SPSS for Windows version 10.0.5J (SPSS Japan Inc, Tokyo, Japan) was employed. Statistical significance was determined using the χ^2-test for and the Mann–Whitney *U*-test based on a level of significance of less than 0.05.

Results

Subject breakdown

A total of 505 of the 14 779 subjects were classified as grade 1 or 2 according to van Herick's classification for at least one eye. The characteristics of the subjects are shown in Table 1.

A total of 923 eyes (473 right eyes and 450 left eyes) were classified as grade 1 or 2. A total of 108 subjects were male (1.9%), whereas 397 subjects were female (4.9%), with women accounting for a significantly higher percentage of the examined subjects ($P<0.0001$, χ^2-test). Although the equivalent spherical refractive error was 1.06 ± 1.57 diopter (D) for the right eye and 1.08 ± 1.49 D for the left eye, indicating that a large number of subjects were hyperopic, there were also 26 right eyes (5.50%) and 31 left eyes (6.89%) with myopia in excess of -1.0 D. The number of narrow angle eyes according to age group is shown in Figure 1. The number of narrow angle eyes increased with age for both men and women.

Comparison between van Herick's classification grade 1 and 2 groups

A total of 78 eyes (39 right and 39 left eyes) were classified as van Herick grade 1, whereas a total of 845 eyes (434 right and 411 left eyes) were classified as van Herick grade 2. The characteristics of each of these groups are shown in Table 2. IOP and equivalent spherical refractive error were significantly higher in the grade 1 group. Although age was also higher in the grade 1 group, there was no significant difference between the two groups.

Table 1 Characteristics of subjects with narrow angle

	Subjects with narrow eyes	*Total subjects*
The number of subjects and eyes	Total 505 subjects (923 eyes) (right eye: 473, left eye: 450)	Total 14779 subjects
Age (years)	Total 66.3±9.2 (male: 66.9±8.6, female: 66.4)	n.a.
Sex (subjects)	Male 108, female 397	Male 5587, female 9192
Equivalent spherical refractive error (diopter, range)	Right 1.06±1.57 D (+8.13 D to −8.5 D)	n.a.
	Left 1.08±1.49 D (+8.63 D to −7.6 D)	n.a.
IOP (mmHg, range)	Right eye: 14.41±2.95 (41–7)	n.a.
	Left eye: 14.33±2.72 (33–5)	n.a.

D = diopter; IOP = intraocular pressure (mean±SD); n.a. = not available.

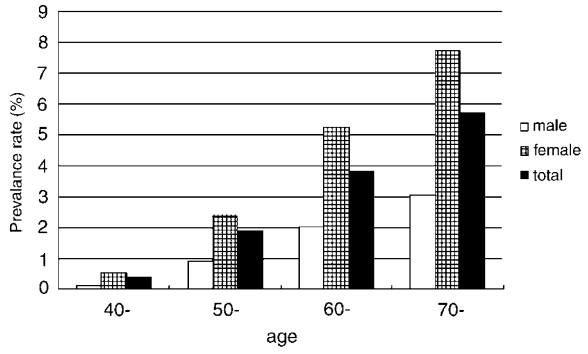

Figure 1 Age and frequency of narrow angle.

Table 2 Comparison between van Herick's classification grade 1 and 2 groups

	Grade 1	*Grade 2*
Subjects (eyes)	43 (78)	460 (845)
Age (years)	680±9.03	66.0±9.27
Equivalent spherical refractive error (D)	1.43±1.33	1.04±1.55*
IOP	15.58±3.84	14.26±2.71**

IOP = intraocular pressure; *$P = 0.014$, **$P = 0.004$, the Mann–Whitney *U*-test.

Frequency of glaucoma suspect and van Herick's classification

Of 505 subjects diagnosed as narrow angle in the primary examination, 376 (75.4%) subjects had the secondary examination including gonioscopic examination. Among these narrow angle eyes, the frequency of glaucoma suspect was 6.6% for the right eye (31/473 eyes) and 6.7% for the left eye (30/450 eyes).

In a comparative study of the grade 1 and 2 eyes, the frequency of grade 1 was 17.9% (14/78) and that of grade 2 was 5.6% (47/845) overall. For the right eye, the frequency of grade 1 was 17.9% (7/39) and that of grade 2 was 5.5% (24/434). For the left eye, the frequency of grade 1 was 17.9% (7/39) and that of grade 2 was 5.6% (23/411). The frequency of grade 1 was significantly higher than that of grade 2 for both the right and left eyes ($P < 0.001$, χ^2-test).

Discussion

In the case of PACG, the deployment of prophylactic procedures for eyes that face a high risk of the occurrence of an ACG attack is extremely important in terms of determining the prognosis of the glaucoma. The measurement of peripheral anterior chamber depth has been previously reported to be effective for the detection of PACG patients by van Herick *et al* and others.[6,8,9] However, there are divergent opinions regarding the usefulness of peripheral anterior chamber depth measurement,[1,7] and there have also been reports indicating the usefulness of central anterior chamber depth measurement.[5] Consequently, a definite conclusion has yet to be reached concerning the usefulness of peripheral anterior chamber depth measurement. There are also few reports describing the usefulness of peripheral anterior chamber depth measurement in Japanese. In this study, peripheral anterior chamber depth was assessed based on van Herick's classification using a larger number of subjects than those of previous reports to determine the usefulness of peripheral anterior chamber depth measurement in the detection of narrow angle eyes and ACG eyes.

In this study, the frequency of narrow angle eyes as determined based on van Herick's classification was revealed to increase with age and to be high particularly among women, and these findings consistent with previous studies on width of angle and anterior chamber depth.[10–12]

Although IOP among subjects classified as grade 2 according to van Herick's classification was the same as that among normal subjects in a glaucoma epidemiological survey conducted in the city of Tajimi (unpublished data), among the subjects classified as grade 1, IOP was significantly higher than those in grade 2 subjects, indicating the possibility that chronic elevated IOP is caused by a narrow angle.

In the epidemiological survey discussed here, a glaucoma epidemiological survey was simultaneously conducted on 4000 subjects who were randomly selected from a total population of 54 126 subjects aged 40 or over of the city of Tajimi, which included the 14 779 subjects enrolled in this study. Therefore, the subjects attending to an ophthalmic epidemiological survey here were different from those for a glaucoma epidemiological survey. Examinations were conducted on 78.1% of the 4000 subjects, indicating a high degree of reliability as an epidemiological survey. As a result of this glaucoma epidemiological survey, the frequency of PACG was found to be 1.12% (confidential interval: 0.74–1.50) and no eyes having a deep peripheral anterior chamber depth, according to van Herick's classification grades 3 and 4, were diagnosed with ACG. According to van Herick *et al*'s[6] report, anterior chamber peripheral depths corresponding to grades 2–1 and 0 of their method can be regarded as carrying a risk of occlusion. All subjects for a glaucoma epidemiological survey had a visual field test and gonioscopic examination, while subjects for an ophthalmic survey did not necessarily have these tests for diagnosis. Therefore, we cannot simply compare the frequency values of ACG between two epidemiological studies. However, we believe that the comparison among the subjects attending an ophthalmic epidemiological study can be acceptable. The frequency of ACG suspect was found to increase significantly among van Herick's classification grade 1 subjects as compared with grade 2 subjects, with the grade 1 subjects exhibiting a frequency that was more than three times higher. Bonomi *et al* reported that van Herick's classification could be useful to screen eyes with narrow angle. However, they also reported that occludable angles evaluated by van Herick's classification were much more frequent than actual ACGs with a ratio of 29 to 1 (95% CI = 19/1–42/1).[13] These results indicate that there is a high possibility of patients assessed with narrow angle eye according to van Herick's classification exhibiting PACG, and the incidence of glaucoma suspect is considered to be high in subjects whose peripheral anterior chamber depth is less than 1/4 the peripheral corneal thickness in particular.

With respect to the usefulness of van Herick's method, Devereux *et al* reported that the sensitivity and specificity for van Herick's classification grade 1 are 83.7 and 85.7%, respectively, whereas those for grade 2 are 99.2 and 65.5%, respectively.[5] On the other hand, Congdon *et al*[7] reported that peripheral slit beam tests such as that of van Herick do not correlate with findings obtained using a gonioscope as well as ultrasonic examination. Judging from the results obtained in this study and those of previous reports, however, van Herick's method is considered to be effective as a screening method for glaucoma patients.

Since gonioscope examination was performed, 75.4% of the subjects diagnosed as narrow angle in this study, there is a possibility of missing some eyes with ACG. Thus, the frequency of a glaucoma epidemiological survey does not necessarily correspond exclusively to the results of this study. In addition, as the optic disc was not evaluated for wide-angle eyes in which the peripheral anterior chamber depth was more than 1/4 of the peripheral corneal thickness, the sensitivity and specificity of van Herick's method cannot be calculated from the results of this study. In addition, because the subjects for this study only accounted for 27.3% of all the subjects of the epidemiological survey and were not extracted randomly, it must also be noted that there is a possibility of bias in patient background.

During peripheral anterior chamber depth observation, the status of the bottom of the angle cannot be diagnosed. Since abnormal signs such as peripheral anterior synechia are also unable to be observed, a gonioscope is required for diagnosing glaucoma. However, as prophylactic treatment is possible for PACG compared to OAG, it is important to screen subjects who have a high risk of occurrence through examination and other means. On the basis of the results of this study, although the measurement of peripheral anterior chamber depth is believed to be useful for glaucoma screening, an ophthalmologist utilizing gonioscope should make the final assessment. It is necessary to develop an affordable and noninvasive method for enabling nonphysicians to evaluate anterior chamber angle as well as testing equipment that allows narrow angle eyes and PACG eyes to be detected easily, safely, and reliably.

Acknowledgements

This study was conducted on the basis of the results obtained from an ophthalmic epidemiological survey conducted in the city of Tajimi.

References

1 Foster PJ, Devereux JG, Alsbirk PH, Lee PS, Uranchimeg D, Machin D *et al*. Detection of gonioscopically occludable angles and primary angle closure glaucoma by estimation of

limbal chamber depth in Asians: modified grading scheme. *Br J Ophthalmol* 2000; **84**: 186–192.
2 Foster PJ, Baasanhu J, Alsbirk PH, Munkhbayar D, Uranchimeg D, Johnson GJ. Glaucoma in Mongolia. A population-based survey in Hovsgol province, northern Mongolia. *Arch Ophthalmol* 1996; **114**: 1235–1241.
3 Hu Z, Zhao ZL, Dong FT. An epidemiological investigation of glaucoma in Beijing and Shun-yi country (Chinese). *Chung-Hua Yen Ko Tsa Chih* 1989; **25**: 115–118.
4 Shiose Y, Kitazawa Y, Tsukahara S, Akamatsu T, Mizokami K, Futa R *et al*. Epidemiology of glaucoma in Japan—a nationwide glaucoma survey. *Jpn J Ophthalmol* 1991; **35**: 133–155.
5 Devereux JG, Foster PJ, Baasanhu J, Uranchimeg D, Lee PS, Erdenbeleig T *et al*. Anterior chamber depth measurement as a screening tool for primary angle-closure glaucoma in an East Asian population. *Arch Ophthalmol* 2000; **118**: 257–263.
6 Van Herick W, Shaffer RN, Schwartz A. Estimation of width of angle of anterior chamber. Incidence and significance of the narrow angle. *Am J Ophthalmol* 1969; **68**: 626–629.
7 Congdon NG, Quigley HA, Hung PT, Wang TH, Ho TC. Screening techniques for angle-closure glaucoma in rural Taiwan. *Acta Ophthalmol Scand* 1996; **74**: 113–119.
8 Thomas R, George T, Braganza A, Muliyil J. The flashlight test and van Herick's test are poor predictors for occludable angles. *Aust N Z J Ophthalmol* 1996; **24**: 251–256.
9 Alsbirk PH. Limbal and axial chamber depth variations. A population study in Eskimos. *Acta Ophthalmol (Copenh)* 1986; **64**: 593–600.
10 Hosny M, Alio JL, Claramonte P, Attia WH, Perez-Santonja JJ. Relationship between anterior chamber depth, refractive state, corneal diameter, and axial length. *J Refract Surg* 2000; **16**: 336–340.
11 Okabe I, Sugiyama K, Taniguchi T, Tomita G, Kitazawa Y. On factors related to the width of anterior chamber angle—multivariate analysis of biometrically determined values. *Nippon Ganka Gakkai Zasshi* 1991; **95**: 486–494.
12 Chen HB, Kashiwagi K, Yamabayashi S, Kinoshita T, Ou B, Tsukahara S. Anterior chamber angle biometry: quadrant variation, age change and sex difference. *Curr Eye Res* 1998; **17**: 120–124.
13 Bonomi L, Marchini G, Marraffa M, Bernardi P, de Franco I, Perfetti S *et al*. Epidemiology of angle-closure glaucoma: prevalence, clinical types, and association with peripheral anterior chamber depth in the Egna–Neumarket Glaucoma Study. *Ophthalmology* 2000; **107**: 998–1003.