Prevalence of glaucoma in the elderly population in Taiwan: The Shihpai Eye Study

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Abstract

Background: This study aimed to evaluate the prevalence, characteristics, and the awareness status of glaucoma in an elderly Chinese population.

Methods: A total of 460 individuals aged ≥72 years were enrolled in this cross-sectional community-based eye disease screening program. Glaucoma was diagnosed according to the diagnostic criteria proposed by the International Society of Geographical and Epidemiological Ophthalmology. Characteristics of subjects with primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (PACG) were described and compared between groups using Mann-Whitney U and Fisher's exact tests.

Results: Forty subjects were diagnosed with glaucoma, including 17 subjects with POAG, 22 with PACG, and one with secondary glaucoma. The estimated prevalence of glaucoma, POAG, and PACG was 8.7%, 3.7%, and 4.8%, respectively. In total, 71% of the subjects with PACG and 77% of POAG subjects presented with a normal intraocular pressure (IOP) of <19 mmHg. The demographic and ocular characteristics were similar between the two groups; however, subjects with POAG had a longer axial length and smaller vertical disc diameter than those with PACG. Further, 95% of the glaucoma subjects ever visited the eye clinic, but only 32.5% of them were aware of the disease.

Conclusion: Glaucoma is prevalent in the elderly population in Taiwan, but the diagnostic rate and disease awareness are low. Since most subjects with glaucoma presented with normal IOPs, optic disc evaluation is critical for diagnosing glaucoma in the elderly in Taiwan

Keywords: Angle-closure glaucoma; Diagnostic screening program; Glaucoma; Open-angle glaucoma

1. INTRODUCTION

Glaucoma is the leading cause of irreversible blindness worldwide.[1] Early diagnosis and intervention are important to prevent glaucoma-related vision loss.[2] However, early detection is extremely difficult because of the asymptomatic nature of several types of glaucoma. In general, the diagnostic rate of glaucoma is <50%, even in developed countries.[3,4] Compared with health insurance programs in the other countries, the National Health Insurance program in Taiwan provides a healthcare system with the least barrier to healthcare access.[5,6] However, the potential benefit of this healthcare system on the diagnostic rate and the awareness of glaucoma is unknown.[7]

The prevalence of glaucoma varies with age and ethnicity. It is important to understand the prevalence of glaucoma in Taiwan through a population-based survey to discern the potential burden of glaucoma-related vision impairment. Reports regarding the prevalence of glaucoma in Taiwan focus mainly on angle-closure disease.[8,9] Hence, the potential burden of glaucoma in Taiwan can only be inferred by analyzing the registration files and claims data of the National Health Insurance program, which would be inevitably underestimated as glaucoma is often underdiagnosed.

The prevalence of glaucoma and other common eye diseases, such as cataract and macular degeneration, increases with age.[10,11] Furthermore, utilization of healthcare resources also increases in the elderly.[12] Therefore, a population-based study on the prevalence of glaucoma in the elderly can yield a more realistic estimation of glaucoma management in terms of socioeconomic burden in Taiwan. This cross-sectional, community-based study aimed to evaluate the prevalence, characteristics, and awareness status of glaucoma in an elderly Chinese population aged ≥72 years in Shihpai, Taiwan.

2. METHODS

This cross-sectional study recruited participants from the Shihpai Eye Study, performed between July 1999 and December 2000. Although this was a follow-up examination study, it was analyzed as a cross-sectional study because the first visit neither included angle examination nor used the current classification

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scheme for glaucoma.[13,14] From the total 1361 participants of the Shihpai Eye Study, we excluded those who had died (n = 205), moved away (n = 301), or had been institutionalized (n = 31). Of the remaining 824 participants, 725 (88.0%) agreed to be interviewed, of whom 460 (55.8%) received ocular examinations between March 2006 and December 2007. All the 460 participants were aged ≥72 years. All the examinations were performed and evaluated by the glaucoma specialists. The Institutional Review Board of Taipei Veterans General Hospital approved this study, and written informed consent was obtained from all participants. All clinical investigations were conducted according to the principles of the Declaration of Helsinki.

A slit lamp (model BQ 900; Haag-Streit, Bern, Switzerland) was used to examine the anterior segment and lens status. Ocular axial length measurement was obtained using an A-scan ultrasonography (AL-1000; Tomey Corp., Aichi, Japan). Noncontact specular microscopy (SD-9000; Konan Inc, Hyogo, Japan) was used to measure central corneal thickness. Baseline intraocular pressure (IOP) was measured using a Goldmann applanation tonometer. IOP was measured twice in each eye. If the difference between the two measurements was within 2 mmHg, the mean of the two readings was recorded. Otherwise, a third measurement was taken and the mean of the three readings was recorded. Spherical equivalent was calculated from the best refractive correction by adding the spherical power with half of the cylindrical power.

Gonioscopy was performed with a Posner 4-mirror lens at a 16-fold magnification in low-ambient illumination by an experienced glaucoma specialist (Y.-C.K.). The angle was graded according to the modified Scheie system in each quadrant. The angle width was denoted as "4" in a wide-open angle with visible ciliary body band, and "0" if none of the angle structures could be observed. A grading of "3, 2, or 1" was given if the scleral spur, pigmented trabecular meshwork, or Schwalbe's line was the deepest structure visible, respectively. An angle was considered occludable if the posterior trabecular meshwork was not visible in >270° in the primary position. Indentation gonioscopy was performed in quadrants graded <2 to identify the presence and extent of the peripheral anterior synechiae (PAS).

Pupil dilatation was performed by applying 1% tropicamide (Mydriacyl; Alcon, Purrs, Belgium) twice with a 10-minute interval for all participants. Post-mydriatic IOP was measured 1 hour after instilling mydriatics. A 78-diopter lens at a 16-fold magnification was used to evaluate the optic nerve head by another experienced glaucoma specialist (T.-M.K.). The vertical and horizontal cup-to-disc ratios (CDRs) and presence of a disc hemorrhage were recorded. The disc diameter was assessed using the measuring graticule of the slit lamp.

Subjects at risk of glaucoma with the following characteristics were invited to have a scheduled threshold visual field (VF) test using the Swedish Interactive Threshold Algorithm standard 24-2 program (Model 750, Humphrey field analyzer; Carl Zeiss Meditec, Inc, Dublin, CA) at Taipei Veterans General Hospital, including those with occludable angles, an IOP ≥19 mmHg, vertical CDR ≥0.7, CDR asymmetry ≥0.2, focal thinning of neuroretinal rim to ≤0.1 disc diameter, disc hemorrhage, evidence suggestive of previous acute angle-closure attack, prior filtering surgery, or iridotomy.

Glaucoma was diagnosed according to the criteria proposed by the International Society of Geographical and Epidemiological Ophthalmology (ISGEO).[13] Glaucoma was classified as primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (PACG) based on the gonioscopic findings. Secondary glaucoma was referred to as the eyes with identifiable cause of increased IOP and associated optic nerve damage. Detailed diagnostic categories for glaucoma are summarized in Table 1.

Table 1

ISGEO diagnostic criteria for glaucoma

Category 1: Evidence of impaired structure and function
Impaired structures include vertical CDR[a] ≥0.8, vertical CDR[a] asymmetry ≥0.35, or neuroretinal rim width ≤0.1. Impaired function was defined by a reliable and compatible glaucomatous VF defect not explained by other diseases.
Category 2: Evidence of advanced structural damage with unproven functional abnormalities
Advanced structural damage with vertical CDR[a] ≥0.85 or vertical CDR[a] asymmetry ≥0.45. No reliable and obtainable VF test results.
Category 3: Unobservable optic disc and lack of obtainable VF test
Best-corrected visual acuity <3/60, accompanied by IOP[a] >23.9 mmHg or history of previous glaucoma surgery

CDR = cup-to-disc ratio; IOP = intraocular pressure; ISGEO = International Society of Geographical and Epidemiological Ophthalmology; VF = visual field.
[a]The criteria of vertical CDR and IOP were defined according to 97.5th and 99.5th percentiles of normal distribution of vertical CDR and IOP of all qualified enrolled participants in this study.

The diagnosis of glaucoma was based on one eye for each individual, and the eye with more advanced disease status was chosen. The right eye was chosen arbitrarily if both eyes were eligible and of similar disease status. Statistical analysis was performed using SPSS statistical software (version 24.0; SPSS, Chicago, IL). The differences between the subjects with POAG and PACG were assessed using the Mann-Whitney U test for continuous variables and Fisher's exact test for categorical variables. A p-value of <0.05 was considered statistically significant.

3. RESULTS

Of the 460 enrolled subjects, 304 (66.1%) were male and 156 (33.9%) were female. The average age of the participants was 78.1 ± 4.1 years (range, 72-93 years). Forty subjects were diagnosed with glaucoma, including 17 subjects with POAG, 22 with PACG, and one with secondary glaucoma. The estimated prevalence of glaucoma, POAG, and PACG was 8.7%, 3.7%, and 4.8%, respectively.

The demographic and clinical features of the subjects with POAG and PACG are listed in Table 2. There was no difference in age and gender between subjects with POAG and PACG. Baseline IOP, post-mydriatic IOP, and best-corrected visual acuity were also similar in both groups. Subjects with POAG had longer axial length than normal subjects (mean ± SD, 24.3 ± 1.4 vs 23.4 ± 1.1, p = 0.03) and PACG subjects. Most subjects with glaucoma, including 12 subjects with POAG (71%) and 17 subjects with PACG (77%), had a presenting IOP of <19 mmHg at the time of screening. The cutoff value of IOP, set at the level of <19 mmHg, was determined based on the 97.5th percentile of the distribution of IOP in the original cohort.[15] Subjects with POAG had a smaller vertical disc diameter than those with PACG. However, the vertical and horizontal CDR did not differ between the two groups. Of all the subjects with glaucoma, only one with POAG was found to have disc hemorrhage. Among the 40 subjects with glaucoma, 38 had ever visited the eye clinics; however, only 13 (32.5%) of them were aware of the diagnosis of glaucoma.

4. DISCUSSION

This is the first population-based cross-sectional glaucoma screening program according to the new diagnostic criteria of ISGEO for glaucoma in Taiwan.[13] The overall prevalence of glaucoma in subjects aged ≥72 years was 8.7% in the Shihpai region. However, according to the 2006 annual report of the Ministry of Health and Welfare, the estimated prevalence of

Table 2

Comparison of demographic data and clinic features between patients with POAG and PACG

	POAG (n = 17) N (%) or mean ± SD	PACG (n = 22) N (%) or mean ± SD	*p*
Sex			
Male	13 (76.5%)	18 (81.8%)	0.71
Mean age (y)	78.4 ± 5.1	78.2 ± 4.2	1
BMI (kg/m^2)	24.9 ± 5.4	24.6 ± 3.3	0.93
Baseline IOP (mmHg)	14.9 ± 3.1	14 ± 2.7	0.44
Post-mydriatic IOP (mmHg)	15.3 ± 4	15.3 ± 3.3	0.91
LogMAR BCVA	0.3 ± 0.2	0.4 ± 0.3	0.66
Spherical equivalence	−0.1 ± 1.5	0.2 ± 2.2	0.19
Lens status[a]			
Phakic	12 (70.6%)	19 (86.4%)	0.26
Pseudophakic	5 (29.4%)	3 (13.6%)	
Axial length (mm)	24.3 ± 1.4	23.2 ± 0.8	0.004*
Pachymetry (μm)	557.4 ± 27.7	557.6 ± 39	0.65
Vertical CDR	0.8 ± 0.1	0.8 ± 0.2	0.66
Horizontal CDR	0.8 ± 0.1	0.8 ± 0.2	0.37
Vertical diameter (μm)	1.9 ± 0.2	2.1 ± 0.3	0.03*
Disc hemorrhage	1 (5.9%)	0 (0%)	0.44

*$p < 0.05$.

BCVA = best-corrected visual acuity; BMI = body mass index; CDR = cup-to-disc ratio; IOP = intraocular pressure; LogMAR = logarithm of the minimum angle of resolution; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma.

[a]The lens status was determined according to the eye with a more advanced disease if the two eyes of a patient were at different disease status.

glaucoma was 4.3% in the population aged ≥70 years, which was projected from the claims data of the National Health Insurance program.[12] Such a discrepancy was not surprising and was most likely due to the underdiagnosis of glaucoma since the claims data identifies only patients with diagnosed glaucoma. According to the study result, the diagnostic rate of glaucoma in Taiwan is possibly <50%, similar to the results reported in other population-based studies.[3,16]

In this study, PACG was the most common type of glaucoma, accounting for 4.8% of the study population, followed by POAG (3.7%) and secondary glaucoma (0.25%). This finding is in agreement with the estimated prevalence of glaucoma in the Chinese population as PACG is the leading subtype of glaucoma, followed by POAG and secondary glaucoma.[17] The prevalence of PACG varies among different ethnicities and populations.[18] In line with our study, He et al.[19] revealed that among 1372 Chinese participants aged 70 to 79 years, the prevalence of PACG was 3.3%. In the Chinese population of Singapore, the prevalence of PACG was 4.2% among individuals aged >70 years.[10] The age-specific prevalence of PACG among patients aged 70 to 79 years varies in other Asian countries; it was 4.12% in the Kumejima study, 0.8% in the Namil study, 1.67% in the Bhaktapur Glaucoma Study, and 0.8% in the Singapore Malay Eye study.[20–23] A higher prevalence of PACG among the Chinese population may be attributed to the difference of the anterior chamber structure compared to subjects of other ethnicities. Chinese eyes have been reported to have a thicker iris, a more anteriorly positioned lens, and a higher prevalence of plateau iris.[24–26] Lens extraction may widen the drainage angle and subsequently, alter the susceptibility to angle closure in the elderly. This study revealed that 13.5% of the subjects had received cataract surgery in both eyes, which is comparable to the lens extraction rate of the Chinese population in Singapore and China.[27,28] Therefore, the distribution of POAG and PACG in this study may not be influenced by the lens extraction rate in this population.

The prevalence rate of POAG in this survey was 3.7%, which is similar to the reported prevalence of POAG in the same age group of other East Asian populations. He et al.[29] reported that the prevalence rate of POAG was 4.12% among 486 participants aged 70 to 79 years in Shanghai, China. The prevalence of POAG was 3% among the adult Chinese population aged >70 years in Singapore.[10] The age-specific prevalence of POAG among patients aged 70 to 79 years was 8.2% in the Tajimi study in Japan and 4.3% in the Namil study in South Korea.[30,31]

This study found that 71% of the subjects with POAG had a presenting IOP of <19 mmHg. The finding is in line with that in Japan and Korea. In the Tajimi study, 92% of subjects with POAG had a presenting IOP of <21 mmHg.[30] In the Namil study, 77% of subjects with POAG had an initial IOP of <21 mmHg.[31] As in the Chinese population, 85% and 75.4% of the POAG subjects in the Liwan Eye Study and the Singapore Chinese Eye study, respectively, had a normal IOP of <21 mmHg.[10,19] The reason for a higher prevalence of normal-tension glaucoma in East Asia remains unclear, but it was found that the mean central cornea thickness was thinner in the Japanese population, which may be surrogate for other anatomic parameters such as thickness and integrity of the lamina cribrosa.[32]

PACG is considered as a pressure-dependent disease with an impaired trabecular outflow pathway secondary to PAS formation. However, many patients with PACG present with a normal IOP. In our study, 77% of the PACG subjects had an IOP of <19 mmHg on presentation. Similar findings were also noted in other population-based studies. Fifty percent of patients with PACG had a normal presenting IOP in the Kumejima study in Japan, and 64.7% of the PACG patients had a presenting IOP of <24 mmHg in the Chennai study.[20,33] Likewise, Oh et al.[34] reported that 60% (97/160) of the PACG patients presented with a normal IOP in a hospital-based study in Korea. The possibility that these patients had undiagnosed normal-tension glaucoma with superimposed age-related angle narrowing cannot be excluded. Nevertheless, the intervention to widen the drainage angle is beneficial for preventing progressive PAS formation and lowering IOP. Therefore, a normal presenting IOP does not exclude the possibility of angle-closure glaucoma, which should be confirmed by gonioscopy in suspicious cases.

In this study, subjects with POAG had a longer axial length and a shorter vertical disc diameter than those with PACG. Previous studies have suggested that the eyes with longer axial length have a larger disc diameter.[35–37] Sihota et al.[38] found that the disc size measured with OCT is smaller in patients with PACG than in those with POAG. The difference of the disc diameter between POAG and PACG in this study may be due to higher ocular magnification in hyperopic eyes in PACG.[39] However, due to the limited number of cases in both groups, a correlation between axial length and disc diameter and the relationship between disc diameter and glaucoma subtypes could not be established.

The discrepancy of glaucoma prevalence identified in this study and estimated from the claims data of the National Health Insurance program (8.7% and 4.3%, respectively), suggested that the diagnostic rate of glaucoma in this age group was around 49.4% in Taiwan. However, according to the response of the participants in this study, only 32.5% of them were aware of the diagnosis of glaucoma even though 95% of them had visited eye clinics for ocular disorders. These findings indicate that clinic-based glaucoma screening and population awareness of glaucoma are inadequate in Taiwan. Our previous study showed that urbanized areas with advantaged neighborhoods, like the Shihpai region, had a higher prevalence of diagnosed POAG than rural areas with disadvantaged neighborhoods.[7] Therefore, some patients with glaucoma may have been diagnosed with glaucoma, but were unaware of their condition. The low diagnostic rate of glaucoma in this study is similar to the findings

in East Asia, which was 20%, 6.7%, and 7.3% in the Chennai, Tajimi, and Namil studies, respectively.[30,31,33] Therefore, a healthcare system with easy access and a low economic barrier, like the National Health Insurance program in Taiwan, did not warrant a better diagnostic rate of glaucoma. These findings indicate the importance of advocating public policies to raise awareness of glaucoma and facilitate clinic-based glaucoma screening to increase the diagnostic rate of glaucoma.

Our study had several limitations. First, it was challenging to conduct a population-based study among the elderly due to the potentially low participation and response rates. This study had a response rate of 55.8% from the original cohort, which is similar to the Rotterdam Study and the Baltimore Eye Survey.[37,40] The low participation rate may lead to a biased estimation of the prevalence of glaucoma. Second, VF test was performed only in subjects at risk of glaucoma. Although all subjects who met the category I structural diagnostic criteria of ISGEO had received VF test, we might still omit glaucoma patients who presented with VF defects earlier than definitive structural damages as defined by the diagnostic criteria of ISGEO. However, the prevalence of glaucoma identified in this study is similar to that identified in other Chinese populations.[13,16,17,27] Therefore, the prevalence noted in this study still provided a crude estimation of glaucoma in the elderly population in Taiwan. Lastly, this study identified the prevalence of glaucoma in the elderly population only, which cannot be extrapolated to any other age group. However, considering the increase in the prevalence of glaucoma with age and the lack of epidemiologic studies pertaining to glaucoma in Taiwan, this study highlights the potential burden of glaucoma in the aging society.

In conclusion, this study revealed the prevalence of glaucoma in the elderly population in Taiwan using a community-based approach. The prevalence of glaucoma in a population aged ≥72 years in an urban area of Taipei, Taiwan, was 8.7%, with a higher prevalence rate of PACG than POAG. Most participants had a presenting IOP of <19 mmHg and were unaware of the diagnosis of glaucoma, despite the fact that almost all of them had ever visited the eye clinics. Therefore, the approach to raise awareness of glaucoma among patients and to increase clinic-based glaucoma screening is important to improve the diagnostic rate of glaucoma in Taiwan.

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